FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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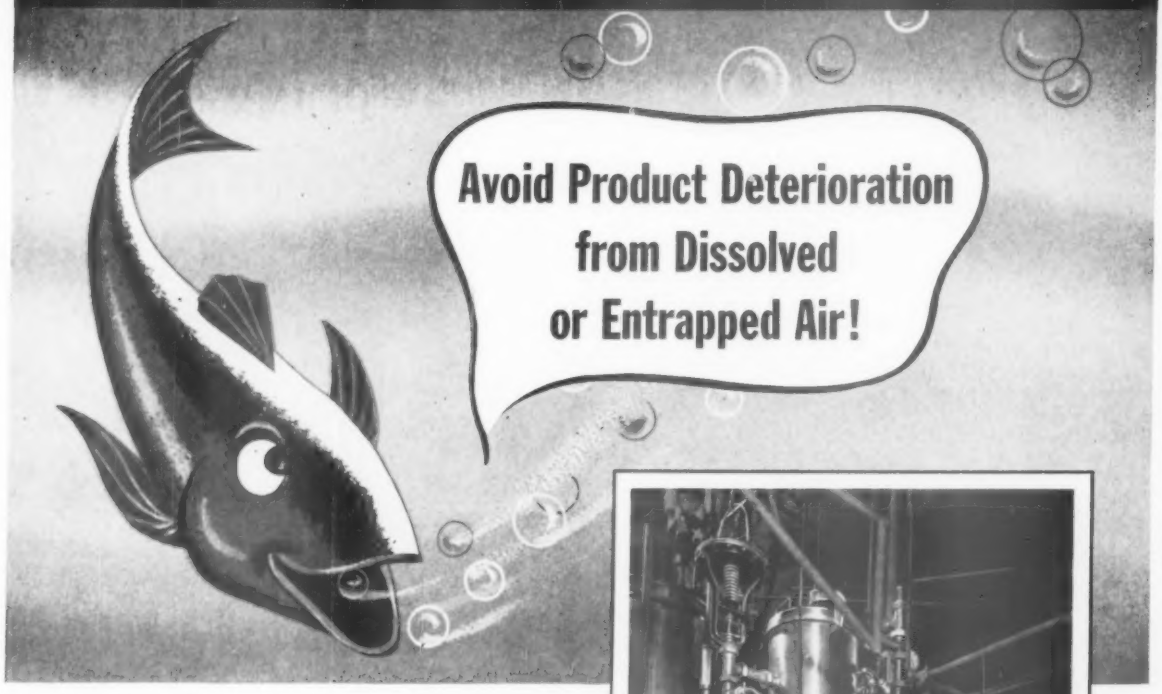

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IFT ACTIONS AND REACTIONS...

A REPORT FROM THE PRESIDENT

At its 1955 Meeting, the Council authorized the production of a Food Technology Career Guidance Brochure. Dr. Peterson, Editor of the Institute Journals, prepared the material and in January, 1956, 5,000 copies were printed. The first limited distribution of the brochure produced such a favorable reaction in industry and among educators that it was decided to give it fairly wide distribution at the High School level, if the necessary funds could be raised.

With the approval of the Executive Committee, letters and copies of the brochure were sent to a number of food industry organizations requesting financial assistance for a nation-wide distribution to High Schools, Guidance Councilors and Teachers, and to individual students who requested it.

An additional 80,000 copies were printed making a total of 85,000. These were distributed as follows:

1 copy to each member of the National Science Teachers Association	10,000 copies
2 copies to each of 30,000 Secondary Schools	60,000 copies
Sold, below cost, to colleges offering Food Technology courses	7,000 copies
Filling individual requests from Students, Teachers and Councilors	6,000 copies
Balance on hand, August 15, 1956	2,000 copies

Individual requests are still being received daily.

The response to the request for financial assistance was most gratifying. The following contributed a total of $10,360.00.

Ac'cent International, Division of International Minerals & Chemical Corporation
The A. D. L. Foundation (Arthur D. Little, Inc.)
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The total cost of the printing and distribution of brochures to date is		$12,754.13
Contributions received	$10,360.00	
Received from sales to Colleges	875.00	11,235.00
NET COST TO THE INSTITUTE		$ 1,519.13

GEORGE F. GARNATZ
President

Southern California Section and Nutrition Foundation to Co-Sponsor Symposium in November

Word comes from Henry N. Espoy, publicity chairman, that a symposium on "Nutritives in Foods and Food in Nutrition" will be presented November 9 under the auspices of the Nutrition Foundation, Inc. and the Southern California Section of the Institute of Food Technologists. To be held at the Huntington Sheraton Hotel in Pasadena, the all-day meeting will have as co-chairmen Dr. Roger Truesdail and Dr. William Baier.

The morning session will be devoted to a discussion of analytical problems of interest to nutritionists while the afternoon session will be devoted to discussions regarding the latest developments in nutrition. The speakers will all be widely recognized authorities in their fields.

In view of the broad interest in the topic, the sessions will be open to all food processors and scientists.

BOOKS...

METHODS OF BIOCHEMICAL ANALYSIS, VOLUME III. Edited by David Glick. Interscience Publishers, Inc., New York, 1956. x + 437 pp. including indices.

This third annual volume in the series initiated in 1954 represents a valuable contribution to the contemporary literature on biochemical methodology.

A broad range of subjects is covered in the twelve chapters which constitute this volume. They are:

Determination of Organic Phosphorus Compounds by Phosphate Analysis, by Olov Lindberg and Lars Ernster.

Assay of Thioctic Acid, by E. L. R. Stokstad, G. R. Seaman, R. J. Davis, and S. H. Hutner.

Quantitative Determination of Histamine, by Charles F. Code and Floyd C. McIntire.

Enzymic Micro Determinations of Uric Acid, Hypoxanthine, Xanthine, Adenine, and Xanthopterine

(Continued on page 8)

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Responsibility for statements appearing in FOOD TECHNOLOGY rests on the author thereof; points of view expressed in the columns of the journal do not necessarily have the endorsement of the Institute of Food Technologists. Mention of commercial products in the technical pages of this Journal is not to be construed as a recommendation of such products over others in the same category.

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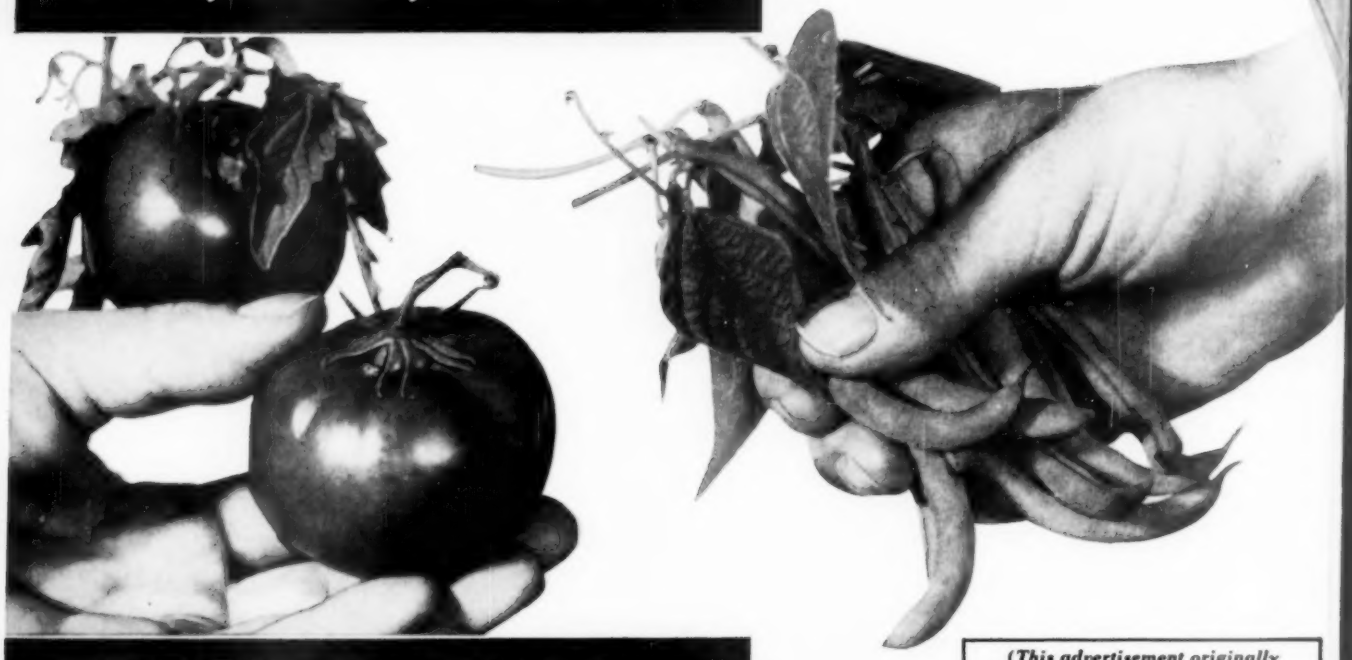

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(Continued from page 2)

by Ultraviolet Spectrophotometry, by Paul Plesner and Herman M. Kalckar.

Use of Periodate Oxidations in Biochemical Analysis, by John R. Dyer.

End Group Analysis of Polysaccharides, by Fred Smith and Rex Montgomery.

Use of Infrared Analysis in the Determination of Carbohydrate Structure, by S. A. Barker, E. J. Bourne, and D. H. Whiffen.

Measurement of Complex Ion Stability by the Use of Ion Exchange Resins, by Jack Schubert.

Analysis of Metal-Protein Complexes, by Thomas R. Hughes and Irving M. Klotz.

Applications of Metal Buffers and Metal Indicators in Biochemistry, by Jürg Raaflaub.

Determination of Zinc in Biological Materials, by Bo G. Malmström.

Flame Photometry and Spectrometry. Principles and Applications, by Marvin Margoshes and Bert L. Valee.

Several of the reviews should be most useful to research scientists studying the biochemistry or chemistry of foods. In particular the chapters on periodate oxidations, end group analysis of polysaccharides, and infrared analysis should be of value to carbohydrate chemists. The review of flame photometry and spectrometry, which incidentally presents some original data, commends itself as a lucid and comprehensive presentation which will be of great interest to many food chemists concerned with trace metal analyses.

GIDEON E. LIVINGSTON
Amherst, Massachusetts

ANNUAL MEETING ANNOUNCEMENTS . . .

SUMMARY OF THE 1957 ANNUAL MEETING TECHNICAL PROGRAM INSTITUTE OF FOOD TECHNOLOGISTS PITTSBURGH, MAY 12-16, 1957

Sessions and Leaders

Packaging
P. B. Reuman, Standard Packaging Corp., 629 Grove St., Jersey City 2, N. J.

Meat and Fish
H. L. A. Tarr, Pacific Fisheries Experimental Station, 898 Richards St., Vancouver, B. C.

Dehydration
W. F. Talburt, Western Utilization Research Branch, U.S.D.A., Albany 10, Calif.

General Session
Food Preservation

Heat	Fermentation
Radiation	Antibiotics

W. B. Esselen, University of Massachusetts, Amherst, Mass.

Frozen Foods
K. G. Dykstra, Birdseye Division, General Foods, 162 South Main St., Albion, New York.

Fruit and Vegetables
A. Kramer, University of Maryland, College Park.

Food Engineering
C. R. Havighorst, *Food Engineering*, 68 Post St., San Francisco, Calif.

Dairy and Poultry Products
K. G. Weckel, University of Wisconsin, Madison 6, Wis.

Sanitation and Sanitizing Agents
W. L. Mallman, Michigan State University, East Lansing, Mich.

Objective Quality Measurements
W. A. Gould, Ohio State University, Agricultural Experiment Station, Wooster, Ohio.

Statistical Quality Control
C. B. Way, Green Giant, Le Sueur, Minn.

Enzymes
E. F. Jansen, Western Utilization Research Branch, U.S.D.A., Albany 10, Calif.

Waste Disposal
C. F. Woodward, Eastern Utilization Research Branch, U.S.D.A., 600 E. Mermaid Lane, Philadelphia, Pa.

Chemicals in Foods
B. L. Oser, Food Research Laboratories
49-14 Thirty-third St., Long Island City, N. Y.

Symposium: Taste Testing and Consumer Preference
E. E. Lockhart, The Coffee Brewing Institute, Inc., 551 Fifth Ave., New York, N. Y.

Deadlines

Titles of papers—November 15, 1956.

Abstracts of papers—December 15, 1956.

Where to submit—To the appropriate chairman (see above).

Dr. I. J. Hutchings, Pittsburgh-in-'57 General Chairman, Announces Committee Members

The Pittsburgh section is already making plans for the National IFT Convention to be held in Pittsburgh next May. Dr. I. J. Hutchings, general chairman of the meeting, has announced the list of members who are serving with him on the committee.

(Continued on page 10)

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(Continued from page 8)

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- Chairman — D. W. Leeper; M. E. Aiken; Joan Lowe; Elizabeth P. Van Kirk; R. Culver; E. N. Higgins

(Continued on page 12)

Vitamin salesman without portfolio

This is Frank Dowe. He handles our sales of vitamin A in the New York area. He's shopping for a brief case because his wife says that anybody who is anybody ought to carry one. So the salesman shows Frank one with a big pocket for samples. No samples in this business, says Frank. So the salesman shows him one with a big pocket for catalogs. No catalogs in this business, says Frank. So the salesman shows him one that looks dressy but doesn't hold anything. But Frank thinks he looks ok as he is and buys a handbag for his wife instead.

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Field Trip (Continued from page 10)

Chairman ..... V. W. Vaurio
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Entertainment

Chairman ..... G. L. Reymann
Asst. Chairman ..... A. N. Laubscher
R. S. Gracey
G. C. Gardner
A. J. Claxton

Ladies' Entertainment

Chairman ..... Helen B. Wigman
Asst. Chairman ..... Mrs. V. W. Vaurio
Melva B. Bakkie
Ruth A. Sparks
Mrs. C. R. Stumbo
Mrs. I. J. Hutchings
Mrs. H. O. Triebold
Veronica Volpe

IFT REGIONAL SECTIONS . . .

SPEECHES, SPECIAL EVENTS, NEWS NOTES

NORTHERN CALIFORNIA . . . .

The August 16 meeting took place at New Milani's, Telegraph and West Grand Avenues, Oakland, California. Social hour 6:30; dinner promptly at 7:30 p.m. Two awards (one Sectional and one National) were made at this meeting. The Cruess Award to Mr. Spiro Spijouras; the Monsanto Award to Dave Eolkin.

Mr. Robert T. Foote, Vice President, Red Star Yeast and Products Company, Milwaukee, Wisconsin spoke on "What Management in the Food Industry Expects from the Research Department." Mr. Foote spoke with authority on this topic, as he is one of the few research directors in the food industries that has climbed to a managerial post.

WESTERN NEW YORK . . . .

Mr. Ned Brown, Operations Chief, Welch Grape Juice Company, Westfield, N. Y., was guest speaker at the first area meeting for 1956-57 (Buffalo Subsection). Mr. Brown discussed "the role of the Technologist in Management," covering the subject from the practical point of view from an operations standpoint. The meeting place was the University of Buffalo, Dining Room A.

PERSONNEL

Some sixty-five friends and alumni of the Department of Food Technology of the Massachusetts Institute of Technology attended the M.I.T. Breakfast held during the national meeting in St. Louis. The program was high-lighted by the presentation to Professor Proctor of the largest can opener on record; namely, a polished stainless steel can opener over three feet long and inscribed, "Professor Bernard E. Proctor, True Exponent of the Art of Appertizing, presented by Alumni and Friends, M.I.T. Breakfast, IFT—St. Louis, Missouri, June 12, 1956."

In addition Professor Proctor was presented with a scroll and Mrs. Proctor was presented with the smallest can opener on record—a three-fourth inch can opener attached to a cultured pearl bracelet.

Dr. David B. Hand, Head of the Department of Food Science and Technology at the New York State Agricultural Experiment Station, has been granted a one-year leave of absence beginning October 1 to undertake a special assignment for the United Nations Children's Fund. Dr. Hand will serve as Food Conservation Officer to assist in the development of protein-rich foods for children throughout the world. The United Nations Children's Fund, generally known as UNICEF, is distributing skim milk to underdeveloped countries and is also assisting milk plants in drying and fluid milk operations. An expanded program is being planned for developing protein concentrates from fish flour, soy beans, cotton seeds, sesame, and peanuts.

The work will be undertaken in cooperation with the Food and Agriculture Organization in Rome, Italy, and the World Health Organization in Geneva, Switzerland.

Dr. Hand has had previous experience in Technical Assistance Programs abroad. In 1953 he made a survey of food processing on Formosa, and this year was a member of a Nutrition Survey Team in Iran and Pakistan.

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FEATURING THIS MONTH . . .

The Development of Cereal Technology at The North Dakota Agricultural Experiment Station*

R. H. Harris
North Dakota Agricultural Experiment Station, Fargo, North Dakota

In 1905 THE NORTH DAKOTA LEGISLATURE passed a bill authorizing the setting up of a milling and baking testing program in the state but did not appropriate any funds for the purpose. In 1907 Dr. E. F. Ladd, chemist, recommended the installation of the small experimental flour mill purchased the previous year. He estimated that a building costing about $6000 would be satisfactory. Later the same year $6500 was appropriated by the legislature to be used in the construction of a building for milling investigations and wheat studies. A three story building was erected as soon as the funds were made available. Besides the mill proper, there were four wheat and flour testing laboratories. The mill consisted of three sets of double roll milling stands, sifters, purifiers and other necessary milling equipment. An experienced miller was also hired and accepted the position for one year.

By 1908 the structure was finished, the milling machinery installed and the laboratories and offices equipped. The immediate object was to determine the milling and baking quality of wheats grown in different parts of the state and of different varieties of wheat. Later the work was to be enlarged so as to benefit millers as well as farmers of the state and possibly also for training students in wheat quality testing.

There is little doubt that the legislature intended the money to be used to study the milling and baking quality of North Dakota wheat with the purpose of improving its quality. However, some of the first work done with wheat consisted in milling and baking studies required for revision of the federal grades for wheat. This work largely occupied the attention of the department until about 1918, when revised standards for wheat became effective on July 15 under the provisions of the United States Grain Standards Act.

Bluestem, Fife and Velvet Chaff were the chief varieties grown in North Dakota at the time the department was originated and on these the first varietal

(Continued on page 16)

* Contribution from the Department of Cereal Technology. Published with the approval of the Director, North Dakota Agricultural Experiment Station, Fargo.

"The Mill," as the original wooden structure was called on campus, housed the Department of Milling and Baking, which grew into the present Department of Cereal Technology.

The new Grain Products Laboratory. The Laboratory contains the Department of Cereal Technology which evaluates the milling, baking and processing quality of new hard red spring and durum wheat and barley varieties. Basic studies on the biochemical properties of these cereals are also carried on.

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(Continued from page 14)

evaluation work was done. About 1913 Marquis made its appearance in the experimental farm plots and in due course was tested for milling and baking quality. Durum wheats proved unsatisfactory for breadmaking, but became quite popular for macaroni production.

In addition to wheat variety investigations the effects of different methods of storage on milling and baking quality were investigated. These studies included the quality of bin-burned, frosted, and bleached wheats. A comparison of the quality of stack and shock threshed wheat was also made for both hard red spring and durum wheats. This work, done in cooperation with the U. S. Department of Agriculture, was the first attempt in this state to investigate wheat quality for industrial utilization, and this mill was the first structure erected solely for wheat milling and baking studies on any campus in the United States. Dr. C. H. Bailey took part in this early work, while enrolled as a student in chemistry under Dr. Ladd. Dr. Ladd later became president of the college.

Allis experimental mill used for milling hard red spring wheats produced in experimental plots. The new milling laboratory shown here has humidity control. Motors, lights and outlets are explosion proof. Dr. R. H. Harris, department chairman, is examining a sample of wheat prior to milling.

Although the type of work was enlarged somewhat by basic studies on wheat starches and gluten under the direction of Dr. C. E. Mangels, the department continued to occupy the old building. The original milling unit, which was essentially a small industrial milling plant requiring 2 bushels of wheat for a test, was dismantled and an Allis-Chalmers experimental mill installed. One important effect of the change was that now a milling and baking test might be made with 10 pounds or less of material, so that wheat produced in experimental plots could be evaluated rather than samples of several bushels from farm fields. The number of samples it was possible to mill was also much increased so that the scope of the work was considerably enlarged.

Ceres wheat was developed at this station by the late Dr. L. R. Waldron and released in 1924. It became widely grown because of its resistance to the prevailing races of stem rust which had been greatly reducing the yields of wheats currently grown, which were not resistant to rust. However, in 1935 new races of rust eliminated Ceres from general farm growth and Thatcher, a Minnesota variety which was resistant to these races, became popular. It was regarded for many years as the standard in quality for hard red spring wheats. It and others released later have become minor varieties in recent years, chiefly because of lack of resistance to race 15 B of stem rust. New varieties, more tolerant or resistant to 15 B, are replacing them.

In 1936 direction of the research program in Cereal Technology was taken over by Dr. Rae H. Harris, following the untimely death of Dr. Mangels.

New Equipment for Wheat Testing

In 1937 the state legislature appropriated funds for the purchase of a small or "micro" flour mill for milling samples from the wheat nursery, thus enabling milling and baking tests to be made several years earlier than was possible with the larger experimental mill. The micro mill was made in Winnipeg according to plans used for similar mills at various cereal laboratories in Canada.

For baking the flours from the micro mill a micro baking method was utilized, which required 25 grams of flour rather than the 100 grams used for the A.A.C.C. "pup" loaf. A little later a mixograph was purchased and now the milling, baking, and physical dough properties of nursery wheats could be evaluated.

The adoption of micro methods caused a marked decrease in the time needed to develop and release a new wheat variety. Varieties judged to be promising in agronomic properties and satisfactory in quality were now quickly advanced to the experimental plots and larger sized samples milled and baked by the older methods. This procedure served as a check upon the micro test results.

Sufficient money was also made available for a durum experimental mill to be used in the production of semolina and for an experimental durum processing unit

Experimental macaroni processing unit, consisting of mixer, kneader and press. L. D. Sibbitt, Assistant Cereal Technologist, is shown adding a measured quantity of distilled water to the semolina in the mixer.

and automatic macaroni drier. This equipment was purchased ready made with the exception of the drier, which had to be constructed locally since no suitable apparatus was available. The acquisition of this equipment acted as a great incentive to the durum investigation and improvement program at this station, and soon

(Continued on page 18)

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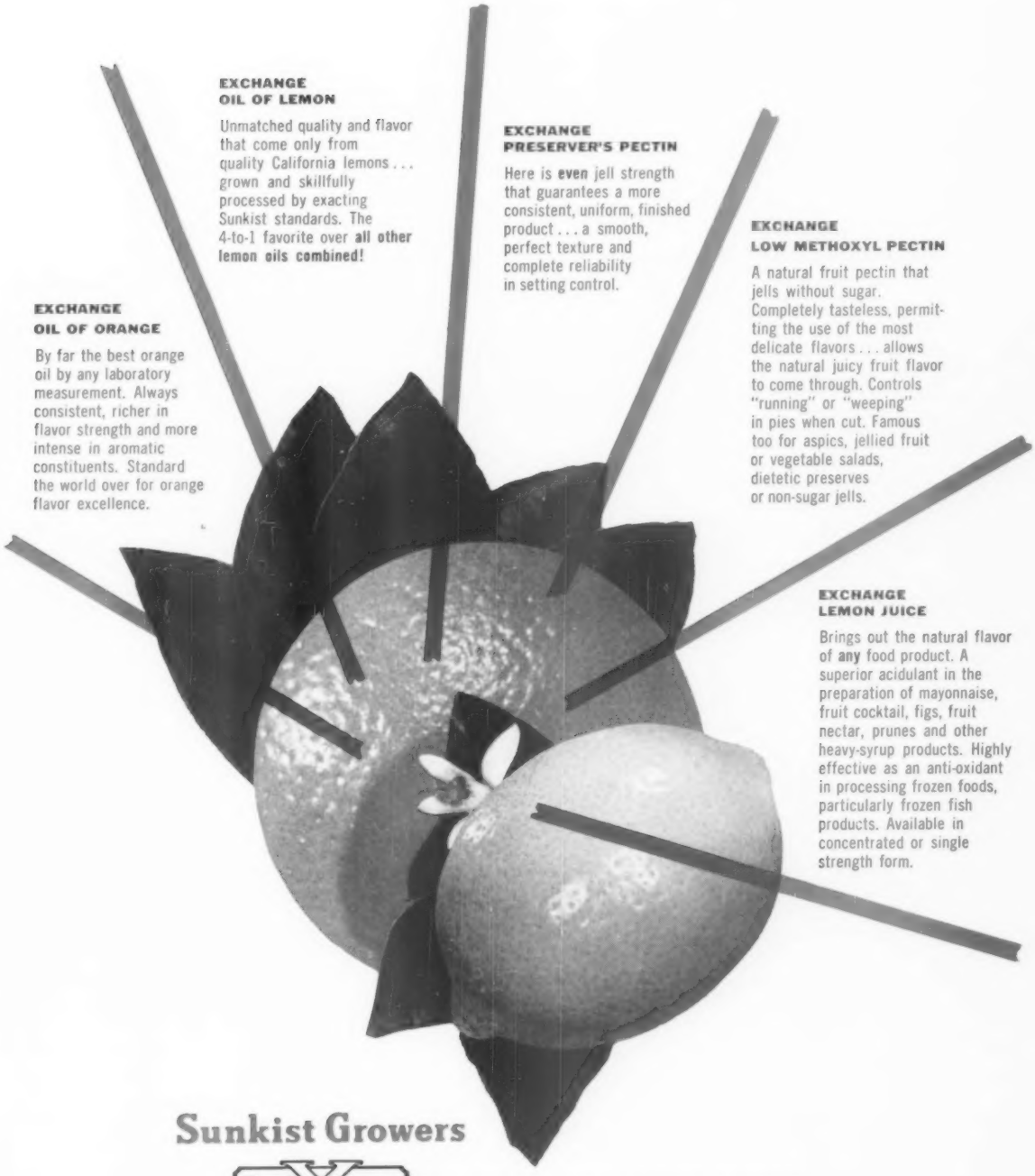

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(Continued from page 16)

a number of new durum varieties were approved for release. Micro-processing durum apparatus was soon installed to permit earlier testing of durum wheats, as for the hard red spring varieties. In the recent 15 B stem rust epidemic the value of the durum testing equipment was shown when four new durum varieties resistant to this rust race and satisfactory for macaroni production were developed and released.

A few years ago a Farinograph and Extensograph were obtained and used in the wheat evaluation program. Flours obtained from the plot wheat samples are now tested for mixing properties and their water absorption determined on the Farinograph, while the changes in physical properties undergone during resting of the dough are assessed on the Extensograph. Any marked deviation in properties in a new wheat from those of standard accepted varieties is cause for doubt regarding the advisability of releasing the wheat for general farm growth in the state. At about the same time a Brabender automatic moisture oven was obtained for determining the moisture content of flour, semolina, ground barley meal and similar material. Wheat moisture content is obtained with a Tag-Heppenstall moisture meter. Other equipment added to assist in more basic studies of the properties of wheat are a super centrifuge, Beckmann spectrophotometer, Hoeppler viscosimeter, etc.

Financial assistance from the Rust Prevention Association for quality studies on the development of new wheat hybrids resistant to 15 B stem rust has greatly helped in the testing program.

Barley Quality Evaluation

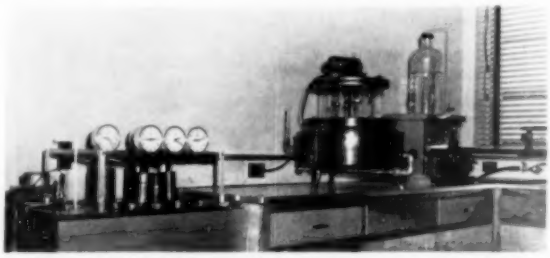
During the last two decades North Dakota has become a major area for the production of malting barley. In recognition of this the Experiment Station decided to intensify its barley breeding work. In 1947 a plant breeder was appointed for a barley breeding project. At the same time a barley quality improvement program was initiated by this department. A water bath suitable for extraction overnight, a cooking bath for extract determination, and some needed glassware were obtained at this time.

The objective of this program was to develop high yielding barley varieties suitable for growth in this state. The varieties should possess good malting quality, strong straw, and resistance to prevailing plant diseases. In addition the new variety should be early enough and heat and drouth resistant to withstand the adverse growing conditions which sometimes occur in this area.

The initial quality work consisted in making barley "prediction" tests on third generation plants without malting. This method requires a minimum of barley and furnishes valuable information on quality at an early stage of the program.

Recently a micro-malting procedure was developed by this laboratory to further increase the efficiency of selection for malting quality in early generations. This procedure entailed the purchase of a steep tank with automatic temperature control and mechanical stirring, the construction of a germinating chamber, and a large drying oven with automatic temperature regulation for drying or kilning the barley when germination had proceeded far enough. A complete malting quality test can now be obtained on the same quantity of grain required for the prediction test. Malting tests are also made on barley varieties grown at six different locations in the state to obtain information on the effect of variations in environmental conditions on different varieties.

On June 29 the Malting Barley Improvement Association approved grants to this Experiment Station for the purchase of a fine grind malt mill and other needed equipment for barley quality evaluation. In addition provision was made for a technician for barley quality work. This recognition by the industry of the significance of the work of the department in barley quality work is appreciated.



View of barley laboratory showing steep tank with alarm clocks for lowering containers into tank at specified times. Barley cooker is also shown.

Grants from year to year by the Malt Research Institute have helped greatly in this barley project, especially in developing the new micro-malting method. Advice and encouragement from Dr. John Parker, Director of the Malting Barley Improvement Association, is also acknowledged, as well as the cooperation of Dr. Allen Dickson, Barley and Malt Quality Laboratory, at Madison, Wis.

Cereal Protein and Starch Research

In addition to evaluating new strains of hard red spring and durum wheat and barley for industrial acceptance and consumer approval the department has consistently carried on investigations with wheat gluten and starch to discover new facts on the influence of these components on processing and utilization properties.

Gluten is particularly intriguing to work with since it is capable of easy separation from starch by the process known to cereal chemists as "washing" without the necessity of employing tedious and time-consuming chemical procedures. It has been shown that the quality of gluten varies between wheat varieties and that when it is fractionated from organic acid dispersion by adjecting the pH with calcium hydroxide fractions of widely divergent qualities are produced. Physicochemical properties of hard red spring and durum glutens differ significantly, and may explain part of the reason at least for the marked differences in gluten characteristics between these two classes of wheat.

Some variations in wheat starch properties have been detected. In some instances, as in baking blends of

(Continued on page 20)

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(Continued from page 18)

starches prepared from different wheats in a mix with a constant uniform gluten, significant differences between wheats have been established. Gels prepared from starch from various wheats have also been shown to vary significantly both as to wheat variety and to location of growth. Recently some preliminary investigations have been carried out on barley starch to characterize the influence of amylase activity on starch. It was found that irrigation had a definite effect on the susceptibility of starch to attack by alpha amylase, and that barley variety was responsible for differences in some starch attributes. Apparently starches from different varieties of the same cereal crop differ significantly in some properties in much the same manner as the protein component.

A New Building

During the 1953 session the North Dakota Legislature, responsive to regional needs, approved funds of $125,000 for the erection of a new Grain Products Laboratory for this department. Bids were received and contracts let in 1954. The building was completed the following year. It consists of three floors, and is approximately 45 x 80 feet. Total floor space is 10,560 square feet. Additional funds in the neighborhood of $20,000 were furnished by the Experiment Station for new up-to-date laboratory furniture. That used in the older building was very poor and ill-adapted to the new laboratories which are larger and of more suitable dimensions. This furniture, consisting of benches, tables, fume hoods, etc., was built by the college Department of Buildings and Grounds to specifications furnished by the staff of Cereal Technology.

Attendants at dedication and inspection of new Grain Products Laboratory grouped at entrance to building.

At a joint meeting of the Canadian Prairie, Winnipeg, and Northwest, Minneapolis, sections of the American Association of Cereal Chemists on April 29, 1956, the building was formally dedicated by Fred S. Hultz, President of the College. Some fifty visitors representing both industry and research, Director Glen C. Holm, and members of the staff of Cereal Technology were in attendance. Dr. Rae H. Harris acted as chairman of the meeting. Dr. Holm spoke briefly on the function of agriculture in the state's economy. Following the dedication the visitors inspected the laboratories and equipment, and then gathered on the steps of the building for a group photograph.

The college library was visited next under the guidance of Chief Librarian H. Dean Stallings and staff. Luncheon was served in the Student Union following a tour of the Union directed by President Hultz and the Union Director Dale Brostrom. A brief talk on early experiences at North Dakota Agricultural College was given by Dr. C. H. Bailey, with special emphasis on cereal and paint chemistry. The meeting closed on a note of appreciation from Dr. D. K. Cunningham, President of the Prairie section, for the visitors.

Future Plans

Future work is planned on the cause of poor mixing quality in wheat, principally through investigations of the properties of wheat protein. This is an interesting field for graduate student work and any light thrown on this question will be very welcome in the field of cereal chemistry and plant breeding. By arrangement with the resident teaching devision of the college it is possible for students for the Master's degree to satisfy the requirements for their thesis by research work in this department. A number have chosen to do this and have gone on to successful careers in industry or academic work.

Soon it is hoped to give class instruction in Cereal Technology, both for specialists and for students in allied subjects, as plant breeding, agronomy, plant physiology, home economics (foods) etc. In addition, it is planned to broaden the graduate work offered, and perhaps finally provide a degree in the field. To achieve this objective an addition to the departmental staff will be necessary.

Abundant Opportunities for a Career in Cereal Technology

Opportunities for specialists in cereal technology are now attractive. At first, openings in the food industry did not tend to offer the same financial appeal as similar opportunities in other segments of chemical activity. Quite recently this situation has changed with the food industries realizing the urgent need for adequately trained personnel. Outside of industry there are a number of openings occurring in Federal, state and regulatory laboratories for cereal technologists as well as a limited number of teaching positions. Some knowledge of the principles of wheat evaluation would seem to be advantageous for all workers in wheat development.

The new and modern facilities naturally increase the opportunities for an expanded and fruitful program of wheat and barley quality research. In the former building adequate space was sadly lacking, and it was often necessary to dismantle equipment and store it in some out-of-the way corner until needed. There was little opportunity for showing the equipment and demonstrating the work performed to interested groups. This situation does not exist now and the department tries to give visitors some idea of the work it is doing toward safeguarding the quality of the wheat and barley crops produced in this state and to afford taxpayers an opportunity to observe how their money is used. The value of exploiting regional resources to the full is becoming increasingly recognized by the public. In North Dakota no citizen is unaware of the historic, the current, and the future importance of "our fields of waving grain."

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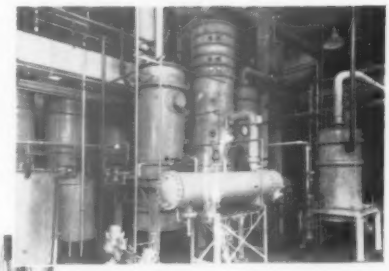

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FOOD INDUSTRY TOPICS . . .

. . . by Norb Leinen

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A warning that many overweight Americans are endangering their health by attempting to lose excess weight through "fad diets" was voiced recently by Miss Rita Campbell, nutrition director of the National Live Stock and Meat Board, 407 S. Dearborn, Chicago. She cautioned that the low-protein diets currently being publicized are at or near the protein level of Indonesia, Yugoslavia, India, Africa, and Central America—where malnutrition is prevalent—and pointed out that in many countries where protein malnutrition exists, there is a high incidence of cirrhosis of the liver and liver tissue. According to Miss Campbell, the recommended reducing diet should contain a liberal amount of protein to protect the reducer's health as well as satisfying his appetite and maintaining his strength. The fat content would be moderate and the chief dietary reduction would be in the carbohydrate foods, she stated. The Meat Board, a non-profit service organization, has provided grants-in-aid for more than 100 nutrition projects at leading colleges, universities, and medical centers during the past three decades. Much of the work has been in the field of protein research.

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A check for $1000 for the furtherance of candy research at the Southern Utilization Branch, USDA, New Orleans, La., was presented recently to the National Confectioners' Assn., 221 N. LaSalle St., Chicago, by the American Association of Candy Technologists. Among problems under study are those connected with wider consumer acceptance, increased use of agricultural products (as new varieties of candy are developed), and development of candies which will not dry out rapidly. At the recent 73rd Annual NCA Convention in Boston, candy manufacturers tripled their research program budget.

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Food Packaging Materials and Methods, Food Engineering Unit Operations, Public Health Aspects of Food Engineering, and Food Engineering Laboratory are four 17-week credit courses being offered in the Evening Division of Illinois Institute of Technology, Technology Center, Chicago 16, Ill., during the semester extending from September 17, 1956, through January 26, 1957.

◆ ◆ ◆

An answer to the ever-increasing problem of nuclear waste-disposal, theoretically worked out as the result of an intensive research project at Brookhaven National Laboratory, has been turned over to the Atomic Energy Department of Blaw-Knox Company's Chemical Plants Division, 300 Sixth Ave., Pittsburgh, Pa., to engineer and incorporate into practical working processes and machinery. The plant developed must be capable of concentrating the waste in solid form, so that liquids will not leach out the radioactivity and contaminate surrounding areas. Once prepared in these sintered powders, research may be continued into the feasibility of securing the material in suitable containers for storage on land or sea. The process planned for the concentration of this waste lends itself to the separation of elements having different radioactive lives. This is expected to offset some of the operating costs by providing isotopes for many industrial, medical research, and food irradiation uses. Even with this distribution of isotopes, however, the eventual problem of final disposal still remains because of their dangerous characteristics.

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Candy lovers are expected to benefit through a new research project on confectioners' fats initiated at Southern Utilization Research Branch, USDA, and to be carried out cooperatively under a research fellowship financed by the NCA. Dr. Werner Landmann, a chemist with extensive experience in research on fats and oils in Paraguay and the U. S., will investigate their behavior in candies, and how they are affected by combination with other ingredients and by methods of processing and handling. He also will obtain information which may be useful in developing new forms of fats and oils "tailored" through chemistry to fit the requirements of confectioners for such materials for specific uses.

◆ ◆ ◆

One of the most significant prospects immediately ahead on the economic scene is a new kind of industry —the research industry—producing new technology as a competitive business activity, Dr. Chas. N. Kimball, president of Midwest Research Institute, 425 Volker Blvd., Kansas City 10, Mo., declared in his recently published annual report to the trustees. "Research," he said, "is a relatively recent arrival on the industrial scene. It has grown by a factor of 50 to 1 over the past 20 years to its present annual expenditure of $5 billion. It is expected to increase to $10 billion by 1965 and $20 billion by 1975." In discussing new ways of doing research, Dr. Kimball said: "As independent scientific organizations, like MRI, make such services available on the open research market, thousands of small and medium-sized businesses in the nation can take advantage of more efficient research. This will produce the answers these companies need and provide essential new product insurance for the future, at costs far below their ability to do it themselves. This is an important way to create new industries. It also will provide growth opportunities for companies not now equipped with enormous technical manpower and research facilities."

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A special course for three quarters, beginning in September, in the basic principles of food and drug plant sanitation and sanitary control, and a special 11-week course, also beginning in September, in the basic principles of candy technology are being offered by Drexel Institute of Technology Evening College,

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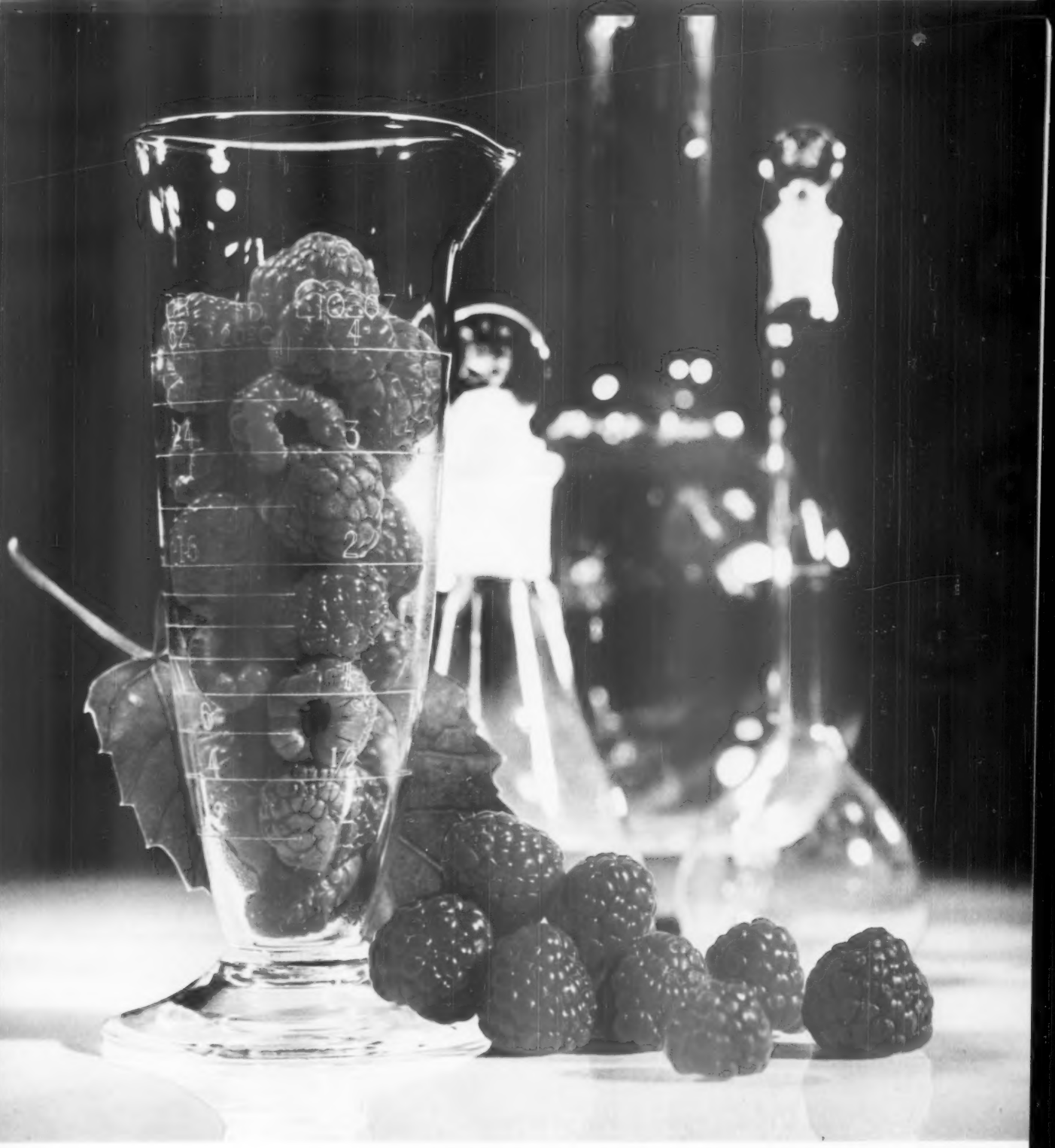

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(Continued from page 22)

32nd and Chestnut Sts., Philadelphia 4, Pa. Tuition for each unit of the first course, and for the entire second course is $45, plus $5 registration fee. Requests for applications should be directed to the Industrial & Student Relations Division of the Evening College.

◆ ◆ ◆

The first shipment of 100,000 pounds of powdered butter, known commercially as Beacreme, was sent from Chicago August 16 aboard the Swedish transport *S. S. Signeborg*, bound for Göteborg, Sweden, and Antwerp, Belgium. In all, 400,000 pounds of the new product will be sent to Sweden, Finland, and Switzerland in a government-sponsored experiment aimed at developing foreign markets for surplus U. S. dairy products. Beacreme is combined from butter and U. S.-produced non-fat dry milk under an exclusive new powder process developed in the laboratories of Beatrice Foods Co., Chicago, and is manufactured in the company's Beloit plant. It will be used abroad industrially in the manufacture of cake and doughnut mixes, confections, and similar products now being packaged for consumers in Europe. One of the product's merits is that it will keep indefinitely. Samples of Beacreme, which contains 72% butterfat, have remained stable for as long as 13 months during tests in the tropics.

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The Department of Food Science and Technology at the New York State Agricultural Experiment Station, Cornell University, Geneva, N. Y., has been given a grant of $12,000 by the Grange League Federation to support a graduate fellowship for four years. The salary of the student is to be $2,200, plus $300 for tuition and fees in Cornell Graduate School. The graduate student selected for this research assistantship will work primarily on development of precooked dehydrated bean products at Geneva. Course work will be done at the Ithaca campus. Any student interested in applying for the assistantship should write to Dr. Keith H. Steinkraus at the address cited at beginning of item.

. . . *things new under the sun*

Two remarkable new developments in meat cans have been announced by American Can Co. One is the development and application of a "no-stick" enamel can lining compound, presently being furnished on ham and luncheon meat cans, that permits the meat products to slip easily out of the opened containers in loaf or bulk form. The other is a new self-tracking tear-strip that makes for much easier opening of key-open cans. Double-bending of the tear-strip provides "tracks" to keep it winding smoothly and easily while being turned on the key.

◆ ◆ ◆

A coarse-type Corn Syrup Solids as a companion product to the firm's popular, finely granulated OK DRI-SWEET Corn Syrup Solids is announced by The Hubinger Co., Keokuk, Iowa. Both products are the carbohydrate solids remaining after removal of most of the water from corn syrup. These products are used extensively in ice cream, baked goods, candy, meat products, frozen fruit, dry food mixes, etc., and contribute the same benefits as liquid corn syrup. The larger granules will be more adaptable to handling in highly humid conditions, particularly those requiring repeated handling of DRI-SWEET in less than 100-lb. bag amounts.

◆ ◆ ◆

Continuous measurement of beer turbidity without laboratory analysis now is possible using the Foxboro Turbidity Detector Recorder, produced by The Foxboro Co., Foxboro, Mass. The unit not only provides a circular chart record of turbidity throughout a run, but can be equipped with a howler or other alarm device to signal the presence of beer haze. The unit is installed with standard electric wiring. Piping consists of a bypass line from the main plant stream to the photometer and return. Complete details are contained in Data Sheet 208-8, free upon request.

◆ ◆ ◆

Information on the VioBin Process, **a simple, inexpensive method for separating the fat from the solid portions of wet fat products** (thus preserving both), is available from VioBin Corp., Monticello, Ill. According to the firm, exhaustive studies show that the nutritional values of the substances are unimpaired. Further, five years of storage at room temperature showed the products to be completely stable. The plant, as it now operates, can process fish, meat, or any other wet fat product into fat and meal.

◆ ◆ ◆

A metal can to meet the specific packaging needs of many powdered and granulated products has been perfected by Continental Can Co., 100 E. 42nd St., New York 17, N. Y. While the lock top makes it simple for consumers to open and reseal the can, the covers are fitted with a pulpboard liner and glassine tamper-proof seal to provide long shelf life, even for hygroscopic products. The containers were styled and proportioned by industrial designers to provide greater space for lithographed design and text on the selling label. In addition, a stacking feature enables the retailer to build up a display of Savorlock cans to the full height of the normal store shelf. Filling and capping is essentially the same operation as the filling and capping of glass jars.

◆ ◆ ◆

In addition to their regular Oil Lemon California Coldpressed, Sunkist Growers, producers of Exchange Brand orange and lemon oils, now offer a second type of lemon oil, the equivalent in aroma, flavor, and quality to the first. This oil will be absolutely pure and USP in every respect, and identical to the standard product, except that it will not come in

(Continued on page 26)

5 WAYS TO FORTIFY MARGARINE WITH **PFIZER** PURE **VITAMIN A**

● The best way you can fortify your margarine is the way that fits into your production most easily . . . and adds maximum nutritional value without affecting taste or odor.

Pfizer has a product to fill your needs exactly—Pfizer Pure Crystalline Vitamin A Acetate or Palmitate in vegetable oil.

In addition to bulk packaging, it is available in batch-size cans (100,000-500,000 U.S.P. units per gram) in any one of five different, convenient formulations:

1. Straight Vitamin A Acetate or Palmitate dissolved in refined winterized cottonseed or corn oil (no color added.)

2. Vitamin A plus Vitamin D (with or without any of the three coloring agents below.)

3. Vitamin A with Pfizer Beta Carotene (a stable, nutritional coloring agent that imparts a uniform, true natural color.)

4. Vitamin A with Pfizer Vegetable Color (The latter is an oil-soluble 20% suspension of microcrystalline annatto color.)

5. Vitamin A with F.D. and C. color added (5 BU or more only.)

Pfizer combination vitamin and color products can be pre-blended to your specifications, so that you can fortify and color with maximum ease and best results. You will find Pfizer Vitamin A odorless, tasteless and highly stable. Count on Pfizer, a leader in vitamin research and development, for products of uniform high quality in convenient forms.

Pioneer and Leading Manufacturer of Vitamins

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CHAS. PFIZER & CO., INC.
Chemical Sales Division
630 Flushing Ave., Brooklyn 6, N. Y.
Branch Offices: Chicago, Ill.; San Francisco, Calif.; Vernon, Calif.; Atlanta, Ga.; Dallas, Texas

(Continued from page 24)

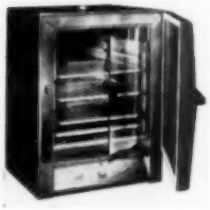
contact with the last half of Sunkist's exclusive dewaxing process. The new oil lemon was designed especially for manufacturers who require a slightly lower priced product, but one that does not differ in the basic essentials from the high quality standard Exchange Brand oils. It will be labeled Exchange Brand Oil Lemon USP, California Coldpressed, Blue Label 413, and priced as follows: 35-lb. cans, $4.50 per pound; 385-lb. drums, $4.50 per pound.

◆ ◆ ◆

In a dramatic demonstration of the strength of the plastic window in the top of a new oyster can, Gordon Tyler (left), plant superintendent of Independent Can Co., Baltimore, Md., strikes the plastic with a metal mallet. The can is held by H. Douglas Huether, general manager. The new-type can is a development of Independent Can, 934 S. Lakewood Ave., Baltimore, and is winning widespread acceptance among housewives who like to see oysters before purchasing. The cans are manufactured of quarter-pound electrolytic tin plate, a product of Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa.

◆ ◆ ◆

A new line of all-metal, electrically heated incubators, featuring increased precision, convenience of operation, and greater safety, has been developed by Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill. The units, which have a temperature range from 37° to 110° C., are designed for use in incubation, drying, embedding, sterilization, and a wide variety of other laboratory and industrial applications. Activity in the inner chamber can be observed without loss of heat by means of a tempered plate glass inner door attached to each incubator. The inner door is carefully fitted and equipped with a latch. Price of the smaller unit (376 sq. in.) is $393.00. The larger unit (920 sq. in.) sells for $472.00.



◆ ◆ ◆

National Aluminate Corporation's Ion Exchange Division, 6216 W. 66th Pl., Chicago 38, Ill., announces development of a **series of new synthetic resin films.** Available in two broad anionic and cationic classes, the new product, called Nalfilm, finds application in deionizing water, electrolyte removal from process liquors, radioactive waste disposal, separating ionic mixtures, salt splitting reactions, preparation of organic acids from their salts, separation of electrolytes from non-electrolytes, uranium purification, and numerous other chemical and electro-chemical processes. Samples, technical literature, pricing, and shipping information on Nalfilm are available without obligation.

◆ ◆ ◆

Price reductions on all grades of its pectin enzymes for clarifying fruit juices and wines were announced by Rohm & Haas Co., Washington Square, Philadelphia 5, Pa., effective July 16. The firm also announced a new member of this group of products, Pectinol RA-5, described as "the most concentrated and economical grade made especially for apple juice clarification."

◆ ◆ ◆

Production of a **new, improved, automatic dispenser for pressure-sensitive labels** is announced by Archer Label Co., 783 Kohler St., Los Angeles 21, Calif. The new dispenser, Multimatic Model 5, speeds up label application as much as 400% over manual methods. While other pressure-sensitive label dispensers are limited to a roll of single labels, the Multimatic will dispense multiple rows. A multiple width roll as wide as 5¾" will contain from 1,000 to 10,000 labels. From two to eight or ten labels can be dispensed at once, depending on the size of the labels. The new dispensers, measuring 9¼" wide by 12" long by 6½" high, are available for immediate delivery. They may also be rented for temporary use.

◆ ◆ ◆

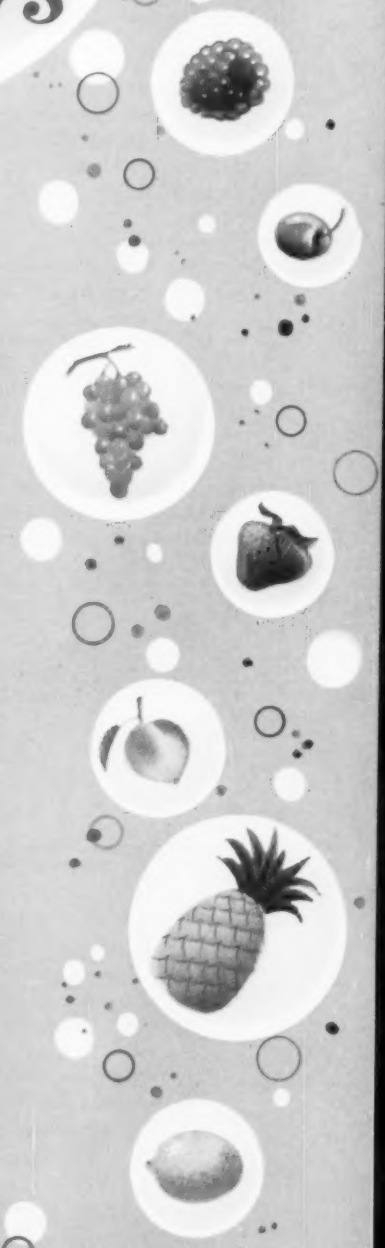
A new, low-cost, automatic, high-speed machine for multi-unit packaging of canned food and grocery products was announced recently by Atlanta Paper Co., Atlanta 2, Ga. Called the Cluster-Pak Automatic Midget, the unit leases for $3,725 the first year, and $25 per month or $300 per year thereafter. Average running speed is 40 cartons per minute. Based on a six-pack, the speed in terms of number of cans is 240 per minute. One person operates the compact unit requiring only 2' by 4' of floor space. The machine can be tied-in directly on the canning line for continuous in-line production. Like other Cluster-Pak models, the new machine locks a multi-unit carton requiring no glue or staples. Two models are available. One, a single-file machine, is adjustable to pack any size can in multiples of two to six units per carton. The other model wraps any size can in double file arrangement of 4 to 12 units per carton.

◆ ◆ ◆

Ribfoil aluminum cups, a new and colorful aluminum foil package, have been introduced by Basca Mfg. Co., 2222 N. Olney St., Indianapolis, Ind. Currently being produced in four, eight, and 16 ounce sizes, the cups have been tested with a variety of foods ranging from fresh fruits to frozen meat products and have shown a high degree of consumer acceptance. Available in seven high-intensity colors—red, gold, green,

(Continued on page 28)

THE Sealva STORY OF "Sealed-In" Flavors



Some years ago, van Ameringen-Haebler, Inc. developed and introduced SEALVA Flavors, the first truly hermetically "sealed-in" high quality dry flavors. This new technique in flavor-making was immediately recognized and enthusiastically accepted by the food industry.

Since those early days, continuing improvements in sealing agents and drying techniques plus the basic superiority in the quality of the natural or imitation flavors themselves, have combined to maintain SEALVA's place as the ultimate in fully protected quality flavors.

What can SEALVA do for your product?

The adoption of SEALVA Flavors makes possible the use of absolute top quality flavor in dry mixes, because the finest of flavors are fully protected in their powdered form against the ravages of deterioration caused by evaporation, oxidation, extended shelf-life, and they are practically impervious to chemical reaction with other ingredients in a mix or compound.

Where can SEALVA Flavors be used to advantage?

SEALVA Flavors are ideal in any relatively dry, powdered, grained, or flaked mixture to insure inert flavor retention in such products as cake mixes, gelatin desserts, cereals, drink powders, pudding mixes, dairy mixes, ice cream mixes, candies (pressed wafer), pharmaceuticals, proprietaries, oil emulsions, etc.

For better flavor we ask you to investigate SEALVA Flavors before you make your final decision on this most important ingredient.

We are prepared to give you suggestions as to the methods of readily evaluating "sealed-in" flavors for your particular product and also will be happy to assist with technical recommendations for the application of SEALVA Flavors to improve your product. Literature and adequate samples are available.

Alva FLAVORS

VAN AMERINGEN-HAEBLER, INC.
521 WEST 57th STREET, NEW YORK 19, NEW YORK

(Continued from page 26)

purple, yellow, blue, and silver—the cups are attractive as serving dishes for foods. They can be filled and capped by high-speed automatic equipment, by semi-automatic process, or by hand. Available as an optional feature, Ribfoil cups can be prepared for hermetic sealing. Samples available.

◆ ◆ ◆

A low-cost, medium-speed machine for loading cans into multiple packages has been designed for canners by Container Corporation of America, 38 S. Dearborn St., Chicago, Ill. The Can Band Loader will load up to 50 cartons a minute, and handles two-, three-, and four-can multiple packages. The firm believes many canners will use the unit for introduction of special promotions in multiple packaging. Canners lease the machine by the month, as they need it. It is also available permanently as part of medium-speed production lines.

◆ ◆ ◆

To combat the problem of excessive foaming in the operation of continuous diffusers, Hodag Chemical Corp., 7247 N. Central Park, Chicago, is introducing a **new, specialized antifoam formulation** labeled Hodag BX-108. Especially designed for effective foam control in the continuous diffusers of beet sugar plants, Hodag BX-108 also is applicable to many similar food and chemical processing situations. Because it is heat-treated, it is low in bacteria content. It is bland in odor, dark amber in color, and weighs 7½ pounds per gallon. Used diluted or applied direct, the antifoam agent is a free-flowing liquid that requires no heating before application. It is easy to handle in automatic systems, can be closely regulated, and doesn't clog drip valves. It is stable for long storage periods, and is effective in small concentrations.

SIX DECADES
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60 years of specialized experience in the manufacture of powdered vanilla products

David Michael has long since mastered the special skills and techniques to create new and highly individual flavorings to fill any specific need, and have been the acknowleged leader in the vanilla field for 60 years.

Let us develop a custom-made flavor for your product in our laboratories and testing kitchen. Research is our keynote—let it work to your advantage!

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Suite 2204 • 203 N. Wabash Ave., Chicago 1, Ill.

CANADA
DAVID MICHAEL & CO., LTD.
801 St. Clarens Ave., Toronto

. . . *the literary corner*

Publication of a new Paint Manual, Tygon Protective Coatings Bulletin No. 760, is announced by The U. S. Stoneware Co., Akron 9, Ohio. The manual is designed for use as a practical work book, presenting useful painting data in the form of charts, tables, diagrams, and illustrations. Virtually all factors relating to the use of Tygon Protective Coatings in mild to severe corrosive services are covered in detail. Write to Robert Hartenstein, Plastics and Synthetics Division.

◆ ◆ ◆

A freeze-drying brochure which fully describes and illustrates their diverse line of seven types of dryers in all price ranges along with 50-odd versatile accessories is offered by E. Machlett & Son, 220 E. 23rd St., New York 10, N. Y. Also included with the brochures is a companion piece describing the newest addition to their line—the Cryovaporator. Utilizing an infra-red attachment, the unit is self-contained and serves as a general freeze-dryer, a desiccator, and a tray dryer. Write for Bulletin FD.

◆ ◆ ◆

Data Sheet 3.7-9, describing a system which can continuously measure and record internal meat temperatures simultaneously in up to as many as 20 smokehouses and meat cookers, is available from Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Aves., Philadelphia 44, Pa.

◆ ◆ ◆

Low level C^{14} counting, H^3 measurements, and fall-out studies of Sr^{90} are among the services described in a new brochure available from Isotopes, Inc., 123 Woodland Ave., Westwood, N. J. Write D. R. Carr, vice president.

◆ ◆ ◆

Heavy duty as well as standard nozzle type centrifuges for use in clarification, separation, and solids concentration are described in Bulletin 1279, issued by The Sharples Corp., 2300 Westmoreland St., Philadelphia 40, Pa. In addition to description of the function and application of both types of Nozljectors, the bulletin describes the method employed to effect high solids concentration and dryness of solids. Centrifuges are described which are capable of handling loads requiring 20 to 50 hp., in even the most severe service. Write to Dept. 298.

◆ ◆ ◆

Detailed in the latest "Rex Report" is an actual case history describing how the J. W. Rex Company cuts paint spraying and finishing costs by 50% on a barbecue tray contract. Cost comparisons for automatic spraying vs. hand spraying are made on a new, continuous line equipped with an electrostatic paint

(Continued on page 30)

Times have changed!

HAVE YOU LOOKED AT GLYCERINE LATELY?

Today, you can specify glycerine with confidence . . . benefit from its many useful physical and chemical properties.

Shell glycerine meets industry's highest standards for purity, and is unsurpassed in uniformity.

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SHELL

(Continued from page 28)

spraying booth. Write for Rex Report No. 1 to Del-Val Finishers Division, J. W. Rex Co., 8th and Franconia Ave., Lansdale, Pa.

◆ ◆ ◆

A 4-page bulletin, No. 491, picturing and describing the firm's line of process instruments is available from the Scientific Instruments Division of Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif. Included are the Beckman Electrolytic Hygrometer, L-B Infrared Analyzer, Leak Detector, Flow Colorimeter, Micro-Microammeter RF Gas Analyzer, pH Control System, and the "111" Data System.

◆ ◆ ◆

An interesting article on *Pyrenone*, non-toxic insecticide exerting at least 10 times the insect knockdown and killing power of pyrethrum alone, produced by the Fairchild Chemical Division of Food Machinery and Chemical Corp., is contained in FMC's publication, *FMC Progress*, Vol. 6, No. 1, 1956. The company's headquarters are located in San Jose, Calif.

◆ ◆ ◆

Informative data on how to cut heat-transfer costs in a wide range of industrial applications is contained in Bulletin IP-356, published by Tranter Mfg., Inc., Platecoil Division, Lansing 4, Mich. The bulletin lists and illustrates 10 major advantages claimed for the Platecoil, and shows how each of them contributes to savings in installation, upkeep, and in initial cost. Complete specifications and dimensions are listed for all four major styles in which the Platecoil is available. Also available is a table for converting lineal feet of pipe coil into equivalent square feet of Platecoil.

◆ ◆ ◆

Glycerine, long established as a tobacco humectant which makes processing easier and preserves the quality of packaged products, now plays an important role in a new development—homogenized tobacco—according to *Glycerine Facts*, August 15, issued by Glycerine Producers Assn., 295 Madison Ave., New York 17, N. Y. Homogenized tobacco, also called reconstituted tobacco, is made from stems and fragments formerly discarded. The tobacco is chopped up and mixed with glycerine to form a paste. Then it is rolled into a sheet, dried and shredded, ready for packing a cigarette.

◆ ◆ ◆

For a copy of the company's Mono, Di, and Triethanolamine Bulletin describing vapor pressure vs. temperature, boiling points of aqueous solutions, surface tension vs. temperature, specific gravity vs. temperature, specific heat vs. composition, freezing point vs. composition, and other properties, write Jefferson Chemical Co., Inc., Box 303, Houston 1, Texas.

◆ ◆ ◆

A second edition of the comprehensive booklet, *Citrus Fruits in Health and Disease*, first published in 1948 by the Florida Citrus Commission, has just been released by the Commission to physicians and other professional groups concerned with nutritional problems and vitamin deficiencies. The new edition, completely revised to include the most recent medical research from sources here and abroad, pays particular attention to the increasing importance of vitamin C deficiency. It includes a totally new section on stress and the general adaptation syndrome, covering the role of vitamin C. Copies may be obtained by writing the Florida Citrus Commission, Lakeland, Fla.

◆ ◆ ◆

"Dried Meat—Early Man's Travel Ration," and a companion article, "New Developments in Meat Drying," comprise the July 1956 issue of *Armour's Analysis*, published by Armour's Livestock Bureau, Union Stock Yards, Chicago 9, Ill.

◆ ◆ ◆

The story of the remarkable, hermetically sealed, nickel-cadmium Voltabloc battery, manufactured by the French Société des Accumulateurs Fixes et de Traction (S.A.F.T.), is featured in an article in the July 1 issue of *France Actuelle*, located at 221 Southern Bldg., Washington, D. C. Because of the interest of the U. S. Navy and of industry, the French S.A.F.T. company, in cooperation with American capital, has formed the SAFT Corporation of America to produce "Voltabloc" in a factory at Lodi, N. J.

◆ ◆ ◆

Precooked frozen fish stick and freezing methods for bakery and other food products have been developed at U. S. Testing Co., Hoboken, N. J., states

(Continued on page 32)

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YOUR GUARANTEE
OF MATCHLESS QUALITY,
PURITY, UNIFORMITY
RITTER & CO
Behind the symbol of the Retort stands three generations of family pride and "know-how" in Essential Aromatics, natural and synthetic flavors, perfumer's specialties. Made in the West's most modern plant. The Retort is your guide to dependability.
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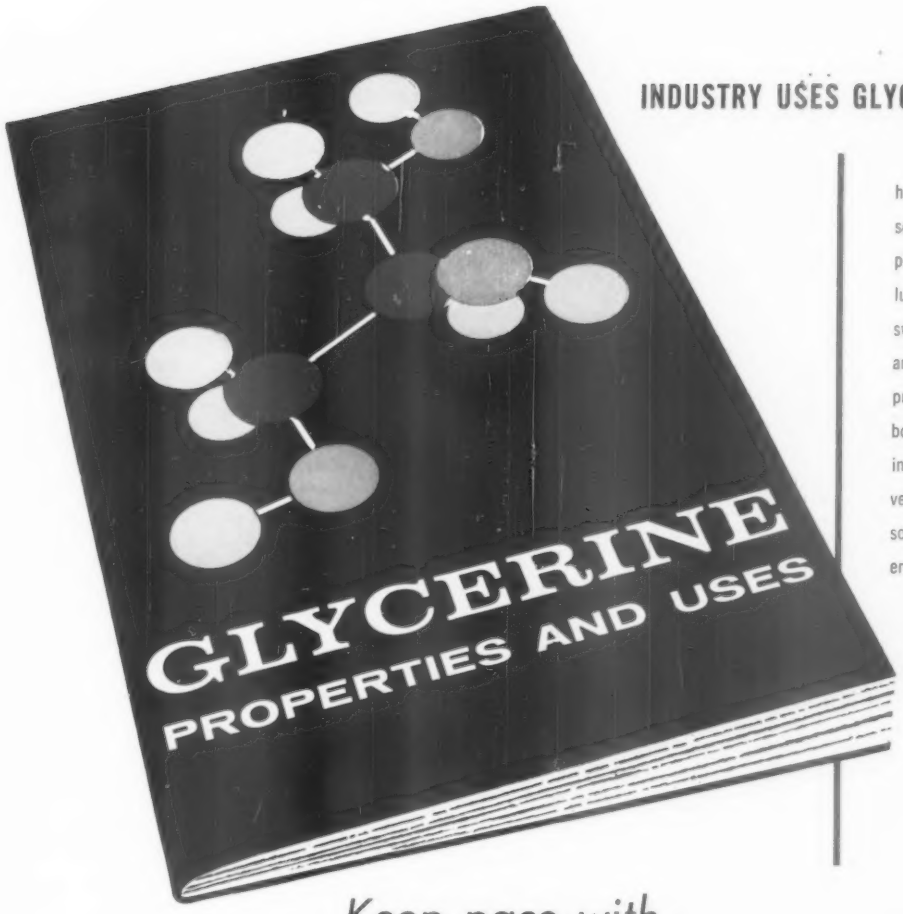

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(Continued from page 30)

"Industrial Research Newsletter," August 1956, published by Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago 16, Ill. Special studies have been conducted to determine evidence of freezer burn on shipments of venison carcasses, cause of spoilage in frozen oyster stew, and damage to frozen hams.

◆ ◆ ◆

A brochure on its smooth panel, hi-tensile steel Volume Van, with its 35% extra payload capacity, is available from Fruehauf Trailer Co., Advertising Dept., Detroit 32, Mich.

◆ ◆ ◆

Bulletin WO-53, published by Layne & Bowler, Inc., Memphis 8, Tenn., completely describes the water- and oil-lubricated Layne vertical turbine pumps, their application, and pump drive heads designed for water wells serving industry, municipalities, and agriculture.

◆ ◆ ◆

The July issue of "Corrosionomics," published by Fansteel Metallurgical Corp., Chemical Equipment Division, North Chicago, Ill., describes the company's acidproof laboratory pilot plant, "a production plant in miniature," available on loan or for purchase. Primarily designed for preliminary heat transfer determinations to aid in development of full-scale plant equipment, the unit is effectively a complete reaction unit. Other uses include distillation, fractionation, reflux studies, rectification, chlorination, bromination, and generation and absorption of hydrochloric or hydrobromic acid. Write for Technical Data Bulletin 3.502.

◆ ◆ ◆

Construction details, operating characteristics, and maintenance features of the new, 6-model line of Clarklift fork trucks are described in a 16-page brochure entitled "Clarklift Features," available from Clark Equipment Co., Industrial Truck Division, Battle Creek, Mich. Included is a list of 34 major components which are interchangeable on all models in the line.

◆ ◆ ◆

Four-page Bulletin Chem C-2, available from Metal & Thermit Corp., Rahway, N. J., describes three general classes of chemical-resisting organic coatings developed to meet the needs of processing industries. The three classes are: 1) Ucilon coating systems applied like paint for general corrosion control, 2) Unichrome plastisol compounds for heavy-duty service, and 3) Unichrome special materials for lining steel drums and tanks.

◆ ◆ ◆

A new 4-page catalog describing the JAco PHOTOPROCESSOR—for precisely controlled processing of all research and analytical photographic emulsions—is offered by Jarrell Ash Co., 26 Farwell St., Newtonville 60, Mass.

◆ ◆ ◆

Brochure W10, offered by Wilkens Instrument & Research, Inc., Acheson Bldg., Berkeley 4, Calif., describes the new Aerograph—a highly perfected instrument for separation of volatile compounds by gas chromatography. Model A100 Master Unit, complete with recorder and packed 5′ stainless steel column, sells for $1250, f.o.b., Berkeley. Companion Model A90, the same as Model A100, but without recorder or recorder accessories, is priced at $750.

◆ ◆ ◆

User's Reports Nos. 2 and 5, describing narrow aisle setups in a small and a large grocery warehousing operation, respectively, are offered by The Raymond Corp., manufacturers of electrical industrial trucks, 50-42 Foundry St., Greene, N. Y.

◆ ◆ ◆

A concise and readily understandable folder in question-and-answer form on electrolized roller chain is available from Atlas Chain and Mfg. Co., West Pittston, Pa. Advantages of the chain in terms of corrosion resistance, higher tensile strength, longer wearing characteristics, and lower costs are set forth.

◆ ◆ ◆

The new 38th edition of *Handbook of Chemistry and Physics*, containing more than 3,000 pages, including over 100 pages of new and revised information, has been published by The Chemical Rubber Co., 2310 Superior Ave., Cleveland 14, Ohio. The book is divided into five major sections—Mathematical Tables, Properties and Physical Constants, General Chemical Tables, Meat and Hygrometry, and Quan-

(Continued on page 34)

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starts with
IN-PLANT CHLORINATION

From start to finish of your processing operation, *Wallace & Tiernan In-Plant Chlorination* will keep your sanitation problems to a minimum by:

Eliminating slime formation on equipment and in work areas

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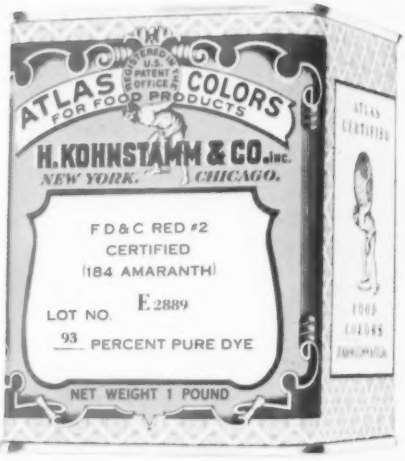
I-46

FOOD NEEDS COLOR



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Please send us your ATLAS FOOD COLOR GUIDE

Name .....

Title .....

(Continued from page 32)

tities and Units. Significant among the revisions is the inclusion of current material on the newest elements—Einsteinium, Fermium, and Mendelevium. Bulletin Roce, a 4-page folder, providing detailed information on the new edition, is available from the company.

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In connection with an article entitled Food Colors under Scrutiny, an informative table presenting the international status of food colors permitted in the U. S. is a feature of the July 1956 issue of "What's New in Food and Drug Research," published by Food Research Laboratories, Inc., 48-14 33rd St., Long Island City 1, N. Y.

. . . *meeting hall and conference room*

Representatives of 25 industrial and government organizations met in Albany, Calif., July 30 to August 1, to discuss results of the comprehensive project on time-temperature tolerance of frozen foods that is now well along in the Western Utilization Research Branch of the USDA. The purpose, explained by M. J. Copley, chief of the Branch, was to counsel with representatives selected by interested organizations on ways and means of achieving maximum usefulness of the results. The over-all effect of the project, according to Dr. Copley, will be to provide information needed in the commercial handling of frozen foods from producer to consumer. No information from the project has been released as yet, but the research staff shortly will begin to publish a series of technical reports.

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A national forum concerned with some of the nation's most pressing problems will be held October 11-13 in New Orleans. The meeting, planned for the 50th Anniversary Observance of the Louisiana Section of ACS, will bring together prominent members of industry, business leaders, outstanding educators, college and high school students. The program will include papers on broad industrial and recent technological developments in certain fields presented by industry speakers. A second phase will consider educational progress and shortcomings as applied to training men for technical and scientific fields. In addition, papers will be presented which will summarize the present position of research activities in the South. Finally, discussions will be held each day of the series to explore ways and means of directing the attention of young people to scientific careers. Further information may be obtained from M. Benton Naff, Loyola University, 6363 St. Charles Ave., New Orleans 18, La.

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ABCB Secretary John J. Riley's 32 years of activity on behalf of the bottled carbonated beverage industry through its trade association will be recognized officially at the 38th Annual Meeting of the American Bottlers of Carbonated Beverages, November 12-15, in Cleveland. At that time, he will be the eighth to receive the ABCB Medal of Industry Service, awarded by vote of the executive board of the association "for outstanding service to the industry." More than 200 exhibitors are expected for the concurrent Soft Drink Industry Exposition, conducted by the ABCB in conjunction with the annual Convention. Hotel reservation forms may be obtained upon request to ABCB, 1128 16th St. N.W., Washington 6, D. C.

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A color-and-sound motion picture portraying the history of ice cream and its important place in the American family's social life will have its premier at the 52nd annual convention of the International Association of Ice Cream Manufacturers in Atlantic City, N. J., October 29-31. Entitled "An Ice Cream Dream," and produced by Liquid Tight Paper Container Assn., 1532 Philadelphia National Bank Bldg., Philadelphia 7, Pa., the 14½-minute film is intended for showings within the industry, on television stations (in black-and-white version), and to school classes and civic and service clubs. For information, write to above address.

. . . *building up and branching out*

In order to accommodate increased business in the Chicago area, Ungerer & Company, Inc., have expanded both their Chicago office and warehouse facilities. The relocated Ungerer Chicago office is now at 1415 Howard St.

◆ ◆ ◆

One of the world's most modern refrigerated storage plants for Sunkist lemons is the Carpinteria Mutual Citrus Association installation in Carpinteria, Calif., dedicated recently. In the photo, J. Donald Smith of York Corp., York, Pa. (center), explains the workings of the refrigeration control panel at the plant to Dan H. Schacht (left), a Mutual grower, and Geo. Holsten, plant manager. The ultra modern refrigeration plant has a storage capacity of 165 carloads of lemons.

◆ ◆ ◆

Spencer Kellogg and Sons, Inc., announce that the firm's Division of Edible Products Research has been established in the Spencer Kellogg Research Center in Cheektowaga, N. Y., a suburb of Buffalo. Mr. Edw. Handschumaker, an IFT member, manager of Edible Products Research, has moved to Buffalo to direct these activities which will be enlarged in the improved facilities of the recently built Research Center. The

(Continued on page 50 following technical papers)

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Like any foundation, a basic seasoning such as pepper must be a skillful composite of the finest materials and artistic craftsmanship. SPISORAMA dry soluble PEPPER is a premium product, made from pure oleoresin black pepper decolorized and standardized at a level of ultimate quality. All the bite, all the time-honored flavor of the world's finest Black Pepper are captured in this product, and made instantly available for maximum utilization in dry soluble form. Absolute freedom from specking is guaranteed, as are maximum purity, potency and predictability. Exacting standards of manufacture, and the use of all stainless steel equipment are our own best assets and our safeguards to you. Trial quantities on request.

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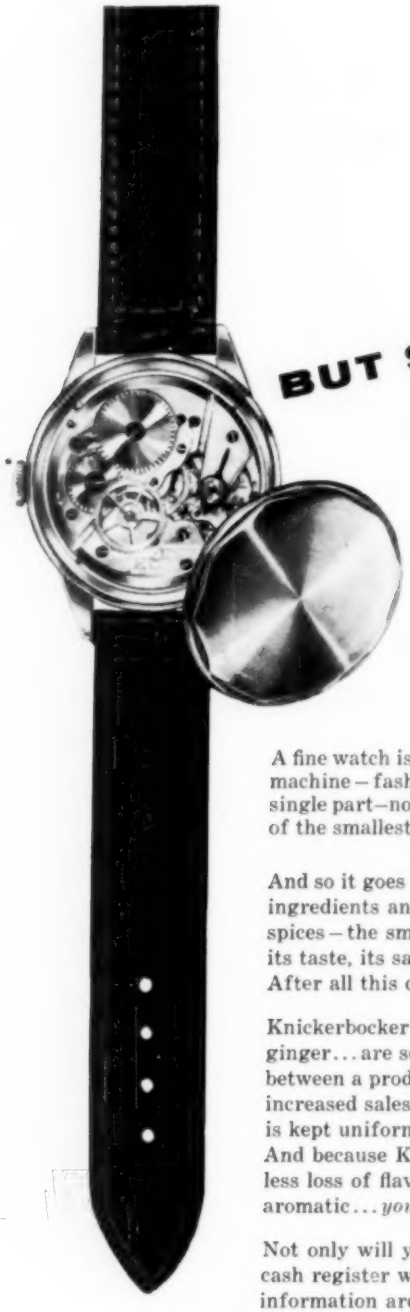

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And so it goes in food processing. Many processors use top grade ingredients and the latest techniques. Yet, when it comes to spices – the small but significant ingredient that gives the product its taste, its sales appeal – many do their skill an injustice. After all this care, they cut corners when it comes to spices.

Knickerbocker spices... cinnamon, mace, nutmeg, paprika, ginger... are selected *for* manufacturers. They make the difference between a product that is just "O.K."– and one which will bring increased sales. From its raw state to its final form, each variety is kept uniform in quality... consistent in strength and flavor. And because Knickerbocker spices are *real* spices... there's less loss of flavor... you'll find they are stronger... more aromatic... *you'll use less!*

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How Management Looks at Industrial Research[a]

Charles N. Kimball, President
Midwest Research Institute,
Kansas City, Missouri

IT WASN'T TOO MANY YEARS AGO that research people had a difficult job convincing other people of the value of their services. Research had to be sold, and sold hard, at all corporate levels, to management, stockholders, and boards of directors. In those days, the research department was quite frequently a pet project of some enlightened top official. When he left the company or passed on, so did the research group.

The last 10 or 20 years have brought about a revolutionary change in management's attitude toward research. One measure of its new status is the 50-fold expansion in research expenditures in the nation over the past 20 years. This broad research effort has created products and processes which have become the basic building blocks of national economic growth. One must not overlook, however, the additional catalytic effect of research upon capital dollars expended for new plants and equipment.

Research is growing by leaps and bounds. The geometric expansion predicted for the next two decades means that our annual present national expenditures of about $5 billion will increase to about $20 billion in 1975. Even this level of effort would account for only 2% of the gross national product. In relative terms, this is indeed a very small investment in the future.

MANAGEMENT EXPECTS MANY THINGS OF RESEARCH

Management expects many more things of research today than it did just a few years ago. Then it was generally accepted that the main responsibility of the research group in a company involved solving technical problems directly connected with that company's present and near future products. These research undertakings arose naturally from day-to-day company operations. Hence, the principal emphasis was on laboratory skills and product improvements.

Today, the objective of nearly every company is product diversification, often extending outside its traditional field of activities. Diversification can be achieved in two major ways, both of which involve research. The first of these is the acquisition of someone else's research efforts through mergers or licensing arrangements; the second involves generating your own diversification in the laboratory.

Today, industry is so critically dependent on the results of research that the research director is often a corporate officer having an equal voice in management affairs with sales, production, and other departments. This growing importance of technical people puts greater emphasis on the new idea and new product development facets of research. Although researchers must still be competent scientific people, they must also now have a keen insight and awareness of things going on outside the laboratory walls. Considerable attention must now be paid by scientists to the economics of technical products and processes, and to long range future product possibilities, based not only on scientific content but also on marketability.

Yes, management expects many things of research today, and these expectations are growing yearly. Certainly, the production of scientific results applicable to tomorrow's new products is of vital importance to management. This is a normal line function.

THE STAFF FUNCTION

But let us consider first the staff function of the research group. Corporate management is becoming increasingly dependent upon all sorts of professional advice, not limited at all to the traditional relationship with attorneys, bankers and financial consultants. Now management is also supplied, either internally or from outside sources, with professional counsel on marketing, operations research, personnel administration and others. A strong research department plays a major role as technical consultants to its own top management. The necessary knowledge to do this must be based not on yesterday's experience in the laboratory, but on broad-gauge background acquired in many fields, and the use by technical administrators of all sorts of information sources. This fairly recent role of the research group must be taken into account seriously when research people are hired today. It requires not only top-rate scientists, but men of broad areas of interest concerned with process costs, marketing and future avenues of corporate activity.

During the course of a research project, organized and regularly scheduled review meetings are fruitful because of the give and take between management and research people. The researchers obtain an insight and awareness of things going on outside their laboratory walls.

The value of the research director and his top staff is multiplied many times when they can serve, with discernment and awareness, as the eyes and ears of management, with respect to new techniques outside the company's normal process or product line. Such techniques may be valuable to other groups in the company. Take operations research for example. A recent definition of OR may be useful here, "the process

[a] Presented before the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 11.

of analyzing and probing into business and its environment is a form of research. When this process involves the use of recognized scientific methods, it is properly called operations research." Operations research is a direct outgrowth of scientific research which has evolved out of traditional laboratory sciences. It will help solve many management problems. Typical are:

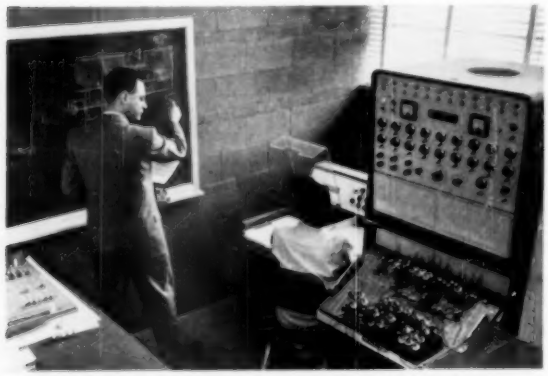
Determining the most effective use of your sales force. Do you call on customers too seldom or too often?

The control of traffic in pipe lines or in factories or in any other material-handling problem.

The best way to lay out retail outlets and other distributive facilities for maximum sales and customer's service. This applies also to warehousing problems.

Top management will benefit greatly from such professional advice, and will apply operations research to many problems outside the research department.

The astute research director will also keep himself—and his management—informed about the use of new computers and their possible role, both in research and in other operating departments. Computers will enable research men of the future to solve problems which today would not even be undertaken because of the enormousness of the work involved. It may even be possible for chemists to use these electronic devices in classifying the hundreds and thousands of known organic compounds, so that multiple uses may be made of many of today's single-use research products.



The alert Research Director keeps himself and his management informed about the use of new computers and their role both in research and in other operating departments.

Top research men will also want to study the applications of automation to various corporate practices. Automation in its broad concept is not at all limited to production. It is not an assortment of control devices, or machines which control other machines. It is basically a different way of doing business, which will demand deliberate planning for technological change. Business today adjusts to its ups and downs by varying the rate of production. This type of reaction to market fluctuations will become increasingly uneconomic. Fixed costs, including amortization of the growing equipment investment will cause break-even points to rise. The permissible margin for management error will shrink continuously, and this will obviously demand new marketing and distributive techniques. For example, automatic controls may permit the rapid processing of sales orders and their automatic translation into production. The implication for the reduction of inventories is quite clear.

Today, the competition among companies and among industries has broadened to the point where it now includes inter-research laboratory rivalry. It no longer suffices to have a superior marketing and sales force—today one must have better scientists. And for this reason another important staff function of the research group is to represent the company on today's widespread technical front.

RESEARCH AS A LINE FUNCTION DIRECTED TOWARD RESULTS

We turn now to the way in which management looks at industrial research, as a line function. Probably the simplest statement is that management seeks results. The definition of "results" depends as much on the sophistication of the management, as it does on the creative ability of the people in the research group. There are two extreme approaches, both widely practiced. One involves focusing all of the company's research talent on the solution of specific problems, which are usually formulated by other groups in the company, such as sales or production. And this often involves using research people to solve technical crises in production, as trouble shooters, or to provide day-to-day technical assistance to sales. At the other extreme, management gives the full responsibility for the generation of all new product and process ideas to the research people. We'll speak more about these two approaches later.

Management wants results from research, but there are as many different ways of evaluating these results as there are companies doing the evaluating. Sometimes the criterion is in terms of products for next year's market (or even for last year's market). Occasionally one sees an enlightened company looking into the future 5, 10 or 20 years. This takes not only research money but management courage.

There have been hundreds of speeches delivered on the subject, "How to get results from research." Suggested solutions vary widely, but four or five basic approaches are most frequently mentioned. The first involves hiring the best available scientific people at any price; purchasing the finest scientific equipment on the market; housing the scientific staff in a beautiful new structure, preferably in a wooded park adjacent to a scenic lake, and then leaving the people alone. Management visits the research group every so often—but not too often—and asks the question, "what's new?"

The second approach is one in which management regards research chiefly as an essential prestige item. There are still some companies who do research because it is fashionable, and it helps to impress the stockholders. Of course, if such an outfit is persistent enough, the pure statistics of continuous effort will produce some useful results.

The third technique is to do everything as inexpen-

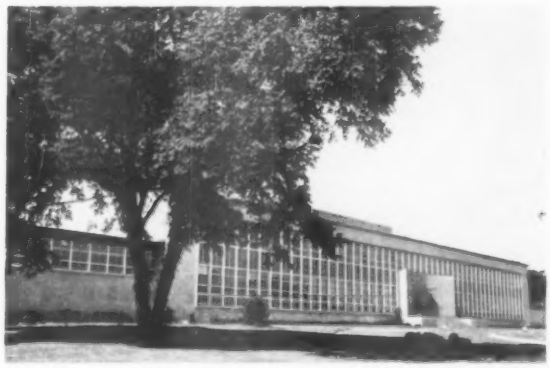
sively as possible. Plant and manufacturing technical people and their equipment are used, in spare time, to do what management calls research.

In the fourth situation, which is intermediate to the others, while adequate equipment is provided, the scientific people are not left alone as in the first illustration. Instead their efforts are scheduled practically on a day-to-day production-line basis.

I am sure it is obvious to you that I have selected extremes to illustrate my point. While some of these approaches are patently undesirable, there remains some question as to whether there is a single best approach applicable to all situations.

ACHIEVING AN ORDERLY APPROACH

Experiences of the Midwest Research Institute doing contract research on a non-profit basis over the past 11 years may be of some significance to you in evaluating your own research techniques. Some of the observations to be made are based on our own direct experience in nearly 2000 different research projects. Others are inferred and distilled from knowledge gained from a



Midwest Research Institute, housed in this new main laboratory building in Kansas City, has completed nearly 2,000 different research projects for 700 sponsors, in 11 years.

wide diversity of research methodology and management attitudes practiced by the 700 sponsors for whom we have worked. Some of these observations may not be new to some of you, but I believe you'll agree on their validity.

To begin with, we have found that it is impossible to do a good job in research and new product development unless the research people have at their disposal a clear and concise elucidation of the specifications the product must meet. This will vary in degree, but without it there can be no orderly approach. Lack of these pertinent objectives probably accounts for a greater percentage of technical failures of new products than does any other single cause. In fact, we consider project objectives so important that in proposals we prepare for sponsors, about half of the proposed content is devoted to a description of the problem and its probable solution. This insures that the sponsor and our staff agree on the research target. Of course, objectives may be changed as time goes along, but one must have an initial milepost against which to measure.

From the research man's point of view, he must be in a position to presuppose that the marketing possibilities for the new product or process have been reasonably ascertained. We occasionally find that a sponsor has not done this—that the research is being undertaken with wishful thinking as one of its principal attributes. In some instances, we have advised the sponsor not to undertake the project, especially when he is poorly informed, or not informed at all, about

The research man in the laboratory must be in a position to presuppose that the marketing possibilities for new products or processes have been reasonably ascertained by the people in marketing research.

whether the new product will sell. Companies can suffer considerable financial harm by developing a food product, for example, which might be technically outstanding, but could not be sold profitably because of excessive cost of ingredients, failure to comply with pure food laws, or deterioration of product with time.

The objective of an experienced research and development group is to reduce laboratory experimental work to a practical minimum. There is nothing more time consuming or expensive than tedious experimental work, especially if only the cut-and-try method is used. It is axiomatic that the experienced researcher will try always to do the last experiment first.

How is this experimental work minimized from a practical point of view? Extensive use of the scientific literature as an obvious first step is valuable, but unless properly done it can be more expensive than the work it is intended to replace. Skillful use of the literature can set useful boundary conditions of feasibility in a project, especially when it can be determined what routes have been tried by others who failed.

Another useful technique involves the use of statistical or probability theory in the design of scientific experiments. When research projects are thus properly designed, much less experimental data are required in studying a problem. Not only is manpower reduced appreciably, but often more precise results are obtained. You will hear much more about this approach as time goes on.

There is no substitute, of course, for a background of experience. In our own case, having completed some 2000 projects, it is infrequent that we ever start a new

The technical library—such as the Linda Hall Library of Science and Technology, Kansas City—is an invaluable repository of knowledge. Extensive use of the scientific library is the obvious first step in minimizing experimental work.

project from scratch. In fact, it is often possible to start a new project at some midway point. This short cut can only be achieved by long exposure of men in widely different scientific fields, to hundreds of widely different problems.

Another important consideration involves progress reports. Normally, we refuse to take on a project unless the sponsor agrees to meet with our technical people monthly. At these meetings, the past month's progress is reviewed, and next month's work is planned. Even on projects of two to three years' ultimate duration it is quite practical and tremendously effective to use this system. Written reports by research workers to management are mandatory, but are really only half the battle. Organized, scheduled project review meetings are additionally fruitful because of the give and take between management and research people in the area of new ideas and research subjects.

The internal organization of scientific manpower and the scheduling of research work vary widely among different organizations. In all but a few groups, however, things must get done on some basis of time commitment. This applies both to the captive labs and the contract research groups. Getting things done does not necessarily mean setting dates for final project completion, but it does mean achieving cardinal points of progress at stated times. One successful approach involves a heavy hand by top research management on meeting scheduled commitments, and a light hand on the control of basic technical content of the project, which is under the supervision of the project leader. One method is to have the research worker make the project commitments himself. This is done at our Institute, and while the conditions as to budget and time are approved by Institute management, they are *not imposed upon the project leader*. He has in effect set his own target dates, and therefore his motivation to succeed is very high.

CREATE AND PRESERVE THE CREATIVE SPIRIT

Obviously the selection, direction and motivation of technical people is all important, if management is to get what it expects from research. I would like in this regard to quote a passage from a speech by Dr. Lee DuBridge, who was your speaker on this occasion at the 1954 meeting of Institute of Food Technologists in Los Angeles. "There really haven't been very many spectacularly productive applied research organizations —civilian or military," says DuBridge. "Wherever you find a highly successful group, I suggest you seek the causes for its success not in the organization chart, not in the budget, not by counting uniforms or rank, not by splendor of buildings or equipment, but by finding a man or small group of men who have created the spirit of the place and who know how to preserve that spirit."

Creative effort has been described as "The imagination that looks forward, foresees, supplies, completes, plans, invents, solves, advances, originates." It is significant that there is not a single passive verb in this whole list.

Only recently have scientists really recognized the part played by creative power. Kettering of General Motors has done much to stimulate this recognition, and so have Dr. Suits of General Electric and many of the younger leaders. The American Society of Mechanical Engineers has conducted seminars solely "to emphasize the importance of creative ability in engineering." The American Chemical Society's Committee on Professional Training recently reported: "It is lack of ability in original thinking that makes far too many men of doctoral training unsuitable for industrial research."

As William James pointed out, "In the dim background of our mind we know what we ought to be doing, but somehow we cannot start. Every moment we expect the spell to break, but it continues, pulse after pulse, and we float with it."

He said also that we all need a definite period for creative thinking, to operate most productively. This rule should govern those of us in research. We should take time out for thinking up ideas—nothing else. Too many businessmen tackle routine first, usually because it is easier. For example, mornings might be reserved for thinking, and afternoons for routine business. Creative thinking must be planned.

Too many research workers are purely problem solvers and are concerned more with the niceties of techniques than with the leaping imagination which results in brand new concepts.

The creative scientist is primarily problem-centered, but the run of the mill researcher is usually means-centered. The latter is concerned with polish, apparatus, buildings, titles, and prestige symbols, while the creative man is concerned with meaningfulness, vitality, and the significance of problems in general—in short, with creativity.

Scientists who are creative find more similarities among their fellow scientists than they find differences, thus a creative spirit finds other creative workers mutually collaborative, irrespective of their degrees, their titles, or their fields of interest.

Having a relatively small group of 260 people at Midwest Research Institute, we not only try to, but have to, follow certain procedures, both in selecting people for creative abilities and in up-grading the creativity of the

others. In selecting creative people, there are no defined tests that one can give. By and large, this is a matter of ascertaining awareness, motivation, frame of mind, psychological background, and, in some cases, economic background.

All the psychological tests ever made point to the conclusion that creative talent is normally distributed—that all of us possess this talent to a lesser or greater degree, and that our creative efficacy varies more in ratio to our output of mental energy than in ratio to our inborn talent. People creatively alert are much more interesting than those who are not. They seem almost to belong to a different species. They see not only what is but what might be; and the power to see what might be is one of the chief traits that distinguish human beings from one another.

WHAT DOES RESEARCH EXPECT OF MANAGEMENT?

We have talked largely about how management looks at industrial research. I have pointed out the desirability of the research department serving as a double-edged management tool; first as technical consultants to corporate management with an awareness of many new technical activities which will influence the long term corporate goals, and secondly as a laboratory source of new ideas, new products and new processes.

This talk will not be complete unless I introduce somewhat of a reverse theme here; namely, "what does research expect of management?" This can be stated very simply.

First, management needs to know and to express what it wants. Research people will work best with clear directives.

Second, management has to maintain a continuity and consistency of interest and support in its research projects to avoid frustrations on the part of its scientific people. The most troublesome client in the contract research business is the itinerant sponsor who can never quite make up his mind as to what he wants.

Third, management needs to integrate the research group emotionally into the corporate picture. The sense of belonging, and the pride of association with a good outfit are compelling motivating forces in management achieving results from research.

Fourth, management needs to reward scientific people adequately. Salaries and fringe benefits are only part of the picture. Status within the corporation, opportunity for self expression and other such subjective factors are growing in importance. The need to support gifted individuals outside normal project activities is one illustration.

Fifth, management in its endeavor to develop useful products and processes from industrial research will want to pay increasing attention to the preselection of people for work in their research departments. Enthusiasm for new knowledge, the judgment to discern what is significant in technical situations, and imagination, the power to see not only what is but what might be, are useful criteria. Drive, concentration and the motivation which leads all real research people to take personal delight in overcoming obstacles are factors which must also be present in marked degree.

RESEARCH IS NO LONGER A LUXURY

Let me conclude with two final observations.

First, research is the keystone of our technological age. There can no longer be any progress without it. Research is no longer a luxury reserved for a few corporate giants, rather it is a basic necessity for any firm of any size which wishes to survive, let alone grow.

Secondly, management gets the kind of performance from its research department which management deserves. Probably the primary ingredient of a successful research program is to give the greatest possible latitude to the most productive and creative people whom it is possible to hire.

With today's participation by scientists in top management responsibilities, it has become necessary to develop increasingly effective methods of communicating ideas, objectives, and results between management and its research staff. This two-way interchange between the scientist and the top administrator is not only feasible but also highly fruitful. Those of you who practice it will no doubt agree.

The Institute of Food Technologists and Your Profession [a]

L. E. Clifcorn, [b]
President, 1955-56, Institute of Food Technologists

LAST YEAR YOU, the members of the INSTITUTE OF FOOD TECHNOLOGISTS, elected me President of your great organization. I end my term of office, in your service, June 13, 1956. It is appropriate that I give you a report of some of the activities of the Institute during the year and say a few words about the profession of food technology and its relationship to you, the food industry, the general public and the Institute of Food Technologists.

Let us reemphasize the definition of our profession as written in the Constitution of the Institute. Food Technology is "defined as the application of science and engineering to the production, processing, packaging, distribution, preparation and utilization of foods. Knowledge of food technology enables its possessor to solve technological problems in one or more of these

[a] Presented at the General Session, June 11, 1956, Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri.

[b] American Can Company, Barrington, Illinois.

fields by the application of the physical or biological sciences, or branches of engineering. It may involve problems in the development of products, processes or equipment; the selection of raw materials; the fundamental changes of composition or physical condition prior to, during, and subsequent to industrial processing; or the nutritional value and health safety of foods."

Through our 4,500 members representing every segment of the food industry, its suppliers and related fields—our profession influences the daily food supply of every American family and the knowledge of food technology throughout the world. The expenditure of one-fourth of the American family income on food, amounting to 67 billion dollars last year, prompts us to recognize our importance and responsibilities which are too often forgotten. The buoyant health of the American people, the abundance, variety, convenience and safety offered in their enjoyment of food, should give great self-satisfaction to every food technologist. One of the greatest accomplishments in America is our food production, processing, packaging and distribution.

Interesting our student population in food technology. As in other disciplines of training in science and engineering, the demand for well trained food technologists exceeds the supply. The Institute has been actively engaged in a program to interest more students, particularly those graduating from high school, to adopt food technology as their professional career. Through the capable efforts of our Executive Secretary, Col. Charles S. Lawrence, and our Editor, Dr. Martin S. Peterson, and their outside assistants, we published and distributed 80,000 copies of a "Career Brochure on Food Technology." These have been well received by high schools, institutions teaching Food Technology, and the food industry. Some of the facts being presented to our American youth to attract their attention are:

1. The food industry is a massive, stable and progressive business.
2. The food market grows with the population, and the population is growing fast.
3. New foods and new food containers that are better, cheaper and more convenient are not only sought by the Industry, they are demanded by the American consumer.
4. Research and technology are vital to the progress of the Food Industry; they will receive increased emphasis in the years ahead.

In 1955, in the United States, there were approximately 4,130,000 births and 1,500,000 deaths with a net increase of 2,500,000 mouths to feed. By 1975 our population will exceed 200 million, which by some experts was once considered the break even point with our annual food production. Beyond this point, in the face of a world shortage, more food will have to be obtained from somewhere if our population is to expand further. The ingeniousness of man in this regard, however, must not be underrated, since greater production of food per acre, per man and per machine will continue for years to come. Better feeding practices for meat production have been discovered, which together with genetics and environment, yield more meat per unit of feed and of higher carcass quality than thought possible a few years ago. Of equal importance to these agricultural accomplishments is that through new food products, processes and packages, food technology will bring even greater enjoyment, nutrition, wholesomeness and convenience in foods than we enjoy today.

Interesting the public in our profession. The profession of food technology is very much like that of chemical engineering in its earlier years. The name is not sufficiently understood by the general public to give our profession the dignity and stature it deserves. To accomplish this tremendous task of public relations in one year is impossible but an objective program of public relations with a persistent continuity of effort was badly needed in the Institute. With the cooperation of your incoming President, Dr. Garnatz, a Committee on Public Relations was established under the Chairmanship of Mr. A. Schaal. The objectives were to elevate the professional stature of each individual member by a stronger system of internal communications within the Institute and to encourage public relations at the Regional Section level by an active speaker's program for women's clubs, business clubs, etc., on subjects dealing with food technology. Through the cooperation of Dr. Peterson, our Editor of Food Technology, and the Committee on Publications, a new section has been started on Food Technology called "IFT Actions and Reactions." It is the purpose of this section to bring to the attention of the members short comprehensive reports of activities and findings pertinent to the food industry, and reports of IFT Committee activities. Reports or releases which are not appropriate to be published are sent to the Regional Section Chairmen who are members of the Committee on Public Relations. It is their duty to see that this information is properly disseminated. With the right cooperation, each member of the Institute may be better informed on food industry matters and accomplish a greater professional stature and recognition in his company and in his community. This is the philosophy behind our public relations program. At least with these basic elements of our program we hope we may encourage each member to assume the level of personal dignity for his profession that it truly deserves.

Our public relations program must be a growing one, year by year adding new facets of activity and never forgetting that our most important responsibility is the growth and stature of the individual member. For next year, I recommend that we request some of the big companies in the food industry to use the theme of the contributions of food technologists to their products as a basis for some of their national popular advertising. There is a terrific story to be told since one of the glorious things about the profession is that in the accomplishment of the goals of the food industry, food technologists are mutually satisfying their own scientific ambitions in making contributions for more and better food for the public use. The American consumer at any economic level today has an abundance of the best and purest food in the world. This is our accom-

plishment. We must get this story across to the public and it is vitally important that the words "food technology" and "food technologist" be properly emphasized.

Our voice should be heard. The food industry is the biggest industry in the United States. It is also the most segmented and in many instances, where there should be unanimity of objectives and policy, it is divided against itself with an overall derimental effect. The Institute of Food Technologists is the only organization in the food industry where all of these segments are represented. At the present time we cannot speak for the food industry or any segment of it regarding scientific, technological or legislative matters pertaining to foods. Of course, we must not put ourselves in the position of a trade organization. However, the Institute of Food Technologists should have a standing committee with a representative from every segment of the food industry as a medium for exchanging viewpoints and arriving at decisions on matters of broad food industry significance. This Committee could also provide a strong liaison with the Food and Drug Administration along the same lines as that of the Liaison Committee of the Pharmaceutical Industry with the Food and Drug Administration which has worked so well. Our good friend—Representative Miller, who will speak to you in a few minutes, is well aware of the necessity for such a Commitee in trying to draw out facts from the food industry relating to legislative matters. I am pleased that the Philadelphia Section has presented a resolution to the Executive Committee and the Council recommending an ad hoc Committee to study the functions and advantages of such a Food Industry Committee.

Ascertaining our professional status. There is considerable interest in the Institute for a survey of the Professional Status of Food Technologists. In fact, one Regional Section has plans for making such a survey of its members. One of our capable and aggressive members, Dr. Roy Morse, has offered to make such a survey and to head a committee to undertake this task on a national basis. A recommendation was made to the Executive Committee and the Council for approval of such an undertaking. I am happy to report that the recommendation has been approved. The results of this survey will show the training, experience, position and duties of our members and the compensation they receive. This information will be collected on an anonymous and confidential basis. When the data are summarized they can be evaluated against data of other comparable professions for given areas. The conclusions will be available to all and for best results should be published. This effort, I am sure, will be most helpful to our profession and its members.

Our hard-working committees. The past year has been a particularly active one with regard to the subject of legislation on incidental and intentional chemicals in foods. As a result of the Federal hearings held in February, it is generally concluded that no bill will be passed on chemicals in foods by Congress during this election year. Your Committee on Chemicals in Foods, under the Chairmanship of Dr. Howard Spencer, has been actively engaged in keeping the members of the Institute informed on the legislative activity on this subject through periodic reports which have been released through your Committee on Public Relations and published in FOOD TECHNOLOGY in the new section, "IFT Actions and Reactions." The timing of these reports and the short time between their release and publication are to be noted with commendation to the Committee on Chemicals in Foods, the Committee on Public Relations, and the Editor of FOOD TECHNOLOGY. They have also prepared a Panel Discussion of the problem of Chemicals in Foods for this program to provide an opportunity for any who are interested or have questions to become fully informed on this important subject.

I have singled out the work of this one Committee because I have worked with it and know its activities well and because it represents clearly the type of service the Institute is bringing to you. The Awards Committee, under the Chairmanship of Mr. Ray Junk, should have particular mention for the fine job they have done in administering our many Awards. This is our first year of operation under a new operational procedure. It has worked very well. The 19 other Committees of the Institute have performed well in the attainment of their objectives. Their reports of significance will again be brought to you through the channels indicated. On behalf of the Institute of Food Technologists, I wish to take this opportunity of thanking all who have devoted their time, effort and in many instances their own expense in serving on our various committees. Acknowledgment must also be recognized to their respective companies who have financially supported these activities.

In September, the Institute of Food Technologists co-sponsored, upon invitation from the Southwest Research Institute, a two day Symposium on Food Physics at San Antonio, Texas. This was a very fine meeting attended by over 100 individuals. Some valuable information was exchanged by those who attended. The Institute should encourage more meetings of this type with organizations and institutions with which we have a common interest. I am happy to note that next year a Symposium on Food Technology and Nutrition, following the same pattern, is to be developed with the Nutrition Society.

One of the obligations of the President of the Institute is to visit as many Regional Sections as possible during his term of President-Elect and President. The Council recently passed a motion requesting that the President visit all of the Regional Sections in the United States and providing him with travelling funds for this purpose. It is my pleasure to report that during the past two years, I have visited 15 of the 23 Regional Sections in the U. S.

Looking ahead. In the horizons ahead are the foods of tomorrow more efficiently produced, processed and distributed through new knowledge gained by the contributions of science and engineering to food technology. Particular effort is made by the food industry in meeting the needs of the American housewife who demands value, quality, and convenience and who wants

foods made by those who understand her problem of feeding and maintaining her family at a moderate cost. In her reception of the products of the food industry, she has assumed an understanding that commercially produced foods are bacteriologically and chemically safe and possess the highest possible nutritive value. This responsibility has been accepted by the American food industry and is executed by food technologists with all the skills offered by science and engineering.

This is an era of convenience. Attempts will be made to win the support of the American housewife for many new and tempting "convenience" food products. Many of the time consuming and burdensome chores of the kitchen will be removed by applications of food technology to the food production line—where they belong. It is the food technologist's role to see that none of these products lack the basic elements of wholesomeness, quality and nutrition. Competition in "convenience" foods will be keen but the American consumer may be assured of a constant flow of exciting new foods and packages to attract her fancy.

Several new principles of food preservation are under intensive investigation today. In particular, we must mention radiation treatment and antibiotics. Considerable concern and difference of opinion exists over the potentialities of radiation treatment of foods. Optimism prevails as an encouragement to the large number of food technologists working in this area. The best authorities on this subject maintain that this optimism is justified and will bring to us, in the not too distant future, some applications of this principle to the preservation of foods. Low energy treatments of radiation for the extension of shelf life and combination treatments with heat, refrigeration and/or antibiotics are particularly potential.

Antibiotics are showing some most interesting results in extending the storage life of poultry, fish, meat and even fruits and vegetables. The application of aureomycin to a poultry dip to extend the freshness and storage life of poultry has been approved for public use by the Food and Drug Administration. Those of you who may have read the article "New Way to Keep Food Fresh," in the March 17, 1956 issue of *Saturday Evening Post* or a digest of this article in the June issue of *Reader's Digest*, know the potentialities of this area of research. Control of spoilage bacteria is the first requirement for effective food preservation. Antibiotics offer us a new tool for this purpose. Further research may develop combinations of antibiotics of sufficiently broad spectrum for effective food preservation even at elevated temperatures.

Combination processes, with or without the knowledge being developed on radiation and antibiotics, will offer new methods for processing foods tomorrow. These processes will not replace canning or freezing but may, in combination with them, increase their overall business and eliminate many of their problems. Some of the most potential combination processes are:

1. Antibiotics—plus refrigeration (35° F. to 45° F.)
2. Antibiotics—plus mild heat (below 212° F.)
3. Radiation—plus refrigeration (35° F. to 45° F.)
4. Radiation—mild heat (below 212° F.)—refrigeration (35° F. to 45° F.)
5. Radiation—mild heat (below 212° F.)—antibiotics
6. Dehydro-freezing
7. Dehydro-canning
8. Salting—dehydration—mild heat (below 212° F.)
9. Baking—freezing.

Foods are complex biological systems, each responding differently to the various preservation processes. Today, more than ever before, we have the opportunity for "tailor made" preservation processes to meet the chemical, bacteriological and enzyme peculiarities of our natural foods.

A challenging era. The food technologist never lived in a more challenging era. Your exciting profession has much to offer the world for better living tomorrow and for the health and security of our children and grandchildren after we are gone. Above all, we are not complacent about the food problems of our future generations. At this Annual Meeting of the Institute of Food Technologists, which the St. Louis Section has so capably arranged for us, we have the opportunity of discussing our food interests and problems in the finest spirit of fellowship and common enterprise. It is this spirit and objectivity which has brought our great profession and the Institute of Food Technologists to where we are today; namely, active and enthusiastic professionally, sound financially, efficiently administered in all departments of our operations. The future holds even greater things for our Institute and its members.

It has indeed been my privilege and pleasure to serve you in the office of President during this past year.

Symposium in Commemoration of the Fiftieth Anniversary of the Food and Drug Law[a]

Moderator: Dr. F. N. Peters, Vice President, Quaker Oats Co., Chicago

I. PROSPECTS FOR FUTURE LEGISLATION ON CHEMICALS IN FOODS

A. L. Miller, M.D., Member of Congress, Fourth District, Nebraska

MR. CHAIRMAN, YOUR GUESTS, LADIES AND GENTLEMEN: I am pleased to have a small part in this symposium which commemorates the 50th Anniversary of the Food and Drug Law. I am happy to be on this panel with such distinguished men as the Moderator, F. N. Peters, Vice President, Quaker Oats Co., Chicago, Ill., George P. Larrick, Commissioner, United States Food and Drug Administration, Eugene H. Holeman, Superintendent of Foods and Drugs, State Department of Agriculture, Nashville, Tenn., Frank L. Gunderson, Consultant, Washington, D. C., and Henry A. Lepper, Past President, Association of Official Agricultural Chemists.

SOME BACKGROUND FACTORS

I propose to talk for a few minutes on the prospects for future legislation relating to chemicals in foods. But before looking into the future, let us have a brief look at past legislation governing food.

It was Teddy Roosevelt who signed the first Food and Drug Act on June 30th, 1906, 50 years ago. The enforcement agency was a small organization at that time. Our country had not begun to grow up. Grandmother and Mother canned and preserved much of the family food and placed it in the cellar for storage. Foods were produced and consumed locally. Since then there has been a revolution going on in the habits of the American people. It is estimated that we are now buying about 80% of our foods from the shelves of the corner store or the large chain cooperative, and we are buying them from manufacturers and processors we have never met and will never know.

It should be remembered that the original legislation on foods and drugs came about because of the deplorable food conditions and the health problems it created in the military during the nineteenth century. History shows that foods served the military in 1898 had deteriorated to the point of being poisonous—some lives were lost. It became a national scandal. It was debated loud and long and fully in the public press and on the Floor of Congress. Demands were made for punishing those responsible for serving spoiled food to the soldiers. A great surge of public opinion swept the country and legislation was finally adopted. We have come a long way in food protection since those days.

It is amazing the number of foods in all the stores that are now completely processed and ready to serve. Some may be frozen and require thawing but they are then ready for almost instant use. Each morning for me the first thing is a cup of hot water and a teaspoon of instant coffee—something that a few years ago was impossible. The housewife buys about 12 times as many frozen vegetable as she bought a decade ago. I understand that frozen orange juice concentrate is 50 times as popular as it was 8 years ago. The business of frozen foods and vegetables has opened up an entirely new field of food processing and handling.

It is appropriate that this organization recognize the good work being carried on by the Food and Drug Administration. For more than 50 years it has been a sort of efficient watch-dog over food and medicine, protecting the public health. They have done a good job, with a limited budget and staff, to make sure that sanitary conditions and foods and medicine are safe for the public.

The original Food and Drug Law was signed for the purpose of safeguarding public health. It is a law for those who deal in the manufacturing, processing, and packaging of food. The law provides a kind of badge of integrity and honesty, setting up a yardstick of standards designed to protect the public and those dealing in all phases of food production. This endorsement is coveted by all groups.

Tremendous progress in the science of food technology has been made in the past few years. This scientific progress has run ahead of the law. In a tough and competitive economic world there will be some who will want to cut corners and apply methods or use chemicals in food that may not have been adequately tested. That is the real reason for a new law.

It is a great credit to the food manufacturing groups and the chemists that they have been cautious and taken strong steps of their own to protect the public. The public has confidence in the administration of the Food and Drug Law. Any new legislative approach must enlarge and insure the continued confidence of the public. I feel sure this huge complex food field needs modern legislation to spell things out and to set up a new yardstick to conduct the business of guarding chemicals in the production of food.

Difficulty has been encountered in trying to move effective legislation to a place where it might be considered by the Congress. Many meetings of the best minds interested in the problem plus public hearings before the Interstate and Foreign Commerce Committee have been held.

There is a sharp difference of opinion between the industry and the Department relative to administrative procedures. I believe the Department opposes the declaratory judgment approach and the injunction procedure.

[a] This Symposium was a feature of the Sixteenth Annual Meeting of the Institute of Food Technologists. The papers were presented Monday afternoon, June 11, 1956, in the Gold Room of the Sheraton-Jefferson Hotel, St. Louis, Missouri.

PREREQUISITES TO NEW LEGISLATION

It is my opinion that new legislation governing the use of chemicals in food will not be adopted until and unless:

1. The public becomes aroused as to its need.
2. Industry itself discards the present general approach that legislation must lean in their favor. (They must have a genuine desire for Legislation that will protect the public interest. They must put the selfish interests as to how it will affect their industry in a secondary position. They must adopt an attitude of cooperation among their associates and one in the interest of the public.)
3. The Department of Health, Education and Welfare makes a determined effort ot get new legislation adopted. (I am recommending, with a letter to the Executive Department, that this be a part of the President's proposed Message to Congress in 1957.)

After many months of study and the introduction of several bills on the question of chemicals in foods, I am convinced that certain segements of the industry are resisting new legislation. One needs only to read the testimony presented by some of the manufacturing and food industry groups to realize that their first and prime consideration is not the public health, but how will it affect my particular industry? how much will it cost? how can we attain legislation that will be slanted in our favor?

I think it is imperative that we protect industry from an arbitrary or capricious Department of Government which, if it did not act wisely, might slow down or completely cripple the use of chemicals in the food industry. But we should all realize that before a chemical is introduced into the food stream it ought to be thoroughly tested as to its safety and its need. We ought not to be drifting along in the horse-and-buggy days—first letting that chemical be tried and then deciding later whether or not it might be injurious to the public's health.

In the legislation that I have introduced I suggest that we follow the same principle as followed in the pesticide bill and have a panel of experts pass judgment on a chemical when a dispute arises between the Department and industry as to whether the chemical is proper and safe. I believe it is far better than asking a Judge or jury to make the decision. The panel of experts must be the top men in their fields. I am a physician. I am sure that my patients seldom ask me for legal advice, and I do not believe that we should expect lay juries or judges to give wise counsel on medical matters. The use of chemicals is a medical problem. That seems to be the core of the differences that now exist in the Interstate and the Foreign Commerce Committee. It is my considered judgment that the difficulties will not be resolved at this Session of Congress. There seems to be desire on the part of certain food manufacturers and chemical groups to resist any move to get good legislation at this time. This has caused an apathy among members of the Committee handling this legislation.

NEW AND STARTLING DEVELOPMENTS AHEAD

The use of chemical ingredients in food is necessary if we are to improve the handling of food. Calcium and sodium propionates retard molding; sorbitol keeps food from drying out. Emulsifiers make cakes, ice cream, and candy smoother. Ascorbic acid prevents browning in a large variety of natural foods. There are new antibiotics that may well revolutionize our present methods of preserving food. Experiments now being carried on by several groups indicate that such things as red meat, fish, and chicken will keep days longer when treated by the different antibiotics. Several new products on the market will double the time that meats may be kept fresh. They are used to retard the growth of bacteria and other related organisms.

The military is experimenting with the use of end products of uranium. There may be a wide new field developed in the treatment and preservation of certain foods by radiation from such sources.

Most of the decomposition of food comes about because of the activity of micro-organisms, bacteria, yeast, and fungi. There is some oxidation as noted in rancid fats and odors. Our grandmothers learned early that heat destroys many of these offending agents. The American Indian learned that you could preserve food by cutting it into thin strips and drying it in the sun over a smoking fire.

Scientists and food technologists may well unlock the door of the future which will provide new and startling uses of chemicals and other scientific devices to increase and preserve our food supply.

NEW LEGISLATION IS NEEDED TO KEEP PACE WITH SCIENCE

In my opinion, considerable educational efforts must be expended before conclusive legislative steps will be taken. I believe we should hold open and free discussions among those directly concerned. The people informed upon the various facets of the law and those who understand the scientific problem should carefully consider all phases of this legislation. Then, there must also exist a real desire to improve the present law.

I am fearful that unless some legislation is adopted to protect the nation's food supply the time may come when adverse publicity may develop because some chemical has caused bad results. If Congress, Industry, and the Executive Department of Government will follow the primary rule that the nation's food supply and health are paramount, and take precedence over what might happen to industry when changes are made, then we can go forward with new legislation. The chemical and food industry ought to be more sensitive to public opinion. We must realize that legislation is needed to keep abreast of the brisk scientific pace.

All groups should agree that mandatory pretesting of food components before that chemical or food is offered to the public is a *must*. They ought to be adequately tested and the tests passed on by the Food and Drug Administration before the chemical enters into our blood stream.

I believe any new law should provide the Food and Drug Administration with adequate machinery to pre-

vent sale in advance of the use of food or other food components which have not been adequately tested for safety. This is an area upon which industry has not been in agreement. There ought to be some machinery and rules, of course, which would prevent any all-powerful dictatorial or bureaucratic food and drug administrator from having the power to choke off or destroy individual initiative and enterprise.

Industry should have a right to give their views before an expert panel. They should have the right to appeal to the courts. I do not believe the final judgment of a single official who would assume responsibility for the safety of each and every new product should go unchallenged. There ought to be some recourse through scientific boards and the courts. All of these processes should be designed to protect the public. While the responsibility for administering the law would be upon the Department of Health, Education and Welfare, the law should give some protection to industry from any arbitrary or capricious ruling that might be made by an administrator. The new law ought not to strangle research but should be constructive and give encouragement to scientific inquiry and progress.

I realize that the Food and Drug Administration does have great powers in the licensing or giving permission for the use of new drugs. There is a feeling of medical urgency in the handling of new drugs, as was illustrated by the Salk Vaccine for polio. The public would not stand for these delays. These same officials seldom feel the public pressure for the approval of new food additives. It is indeed difficult to establish the absolute safety of any food chemical. You and I as human beings even react differently to unadulterated food.

Manufacturers may complain of an error in judgment made by the Administrator and they should have recourse through an expert panel or the courts. I submit, however, if an error is to be made it ought to be made on the side of safety. The new chemical ought not to be permitted until we are certain that it is safe. The burden of proving this safety belongs to the group producing the chemical for use in food. It does not rest with the Government.

In some of our hearings and contacts with the industry it seems that some of the groups who insist on the use of injunctions, declaratory judgment or de novo procedures, if they are successful, would tie the hands of any food or drug administrator. I have felt there has been little cooperation from some of these groups in our efforts to get a good chemicals-in-foods bill.

A COURSE OF ACTION

I expect to write the President of the United States, whoever he may be, and suggest that in his next Message to the Congress that a provision be inserted which calls for new legislation on the use of chemicals in food. This will give the legislation new life and new urgency. It will give incentive to all groups to reach a compromise that should be productive of sound constructive legislation.

Time is not likely to permit the passage of new food and drug legislation at this session of the 84th Congress. The 85th Congress will, in my judgment, pass some legislation. New legislation will be a certainty, however, if such a request is contained in the next Presidential Message to the Congress.

II. PURE FOOD AND PROGRESS

George P. Larrick, Commissioner of Food and Drugs, Department of Health, Education, and Welfare

ABRAHAM LINCOLN once said that good government exists to do for the citizen what he cannot do for himself. Our food laws are instruments of that kind of government.

Fifty years ago this month Dr. Harvey W. Wiley was engaged in the final stages of his 23-year campaign for a Federal food and drug law. His efforts culminated on June 30, 1906, when President Theodore Roosevelt signed the Meat Inspection Act and the original Pure Food and Drugs Act. As the Golden Anniversary of these basic and important Federal laws, this year will be celebrated both as a milestone of progress in social legislation and as a landmark of accomplishment in food technology, which, together, have given this Nation the best food supply in the world.

It would be appropriate, at this time, briefly to review the development of our food laws and to touch upon some of the phases of food technology that have had a bearing on food regulation.

Need for control of commerce in food seems to be as old as history itself. In the earliest times, foods were few and simple, and trade was carried on mostly through bargain and barter. The rule of *caveat emptor* was as accepted in the food business as it was in horse-trading. Even so, ancient food laws existed, provisions of which often parallel those of modern legislation. Leviticus 7:24, for example, admonishes that: " . . . the fat of the beast that dieth of itself . . . may be used in any other use: but ye shall in no wise eat of it."

During the Middle Ages, mercantile interests, rather than religious or temporal authorities, took the lead in food regulation for a considerable period. The powerful trade guilds of Europe exercised more or less control over the activities and products of their members. It was usually directed toward mitigation of disruptive trade practices, rather than exerted in any particular concern for the ultimate consumer.

That was likewise a dominant motive of earlier food laws of various States in this country, the first of which was enacted by Massachusetts in 1784. During the following century or so, coincident with development of democratic ideals and recognition of the rights of the individual, motivation behind food legislation gradually shifted. When the Federal laws were finally enacted in 1906 they were strongly characterized by emphasis on consumer interest, or in a broader sense, *public* interest.

That slant to this legislation was not easy for a man in Harvey W. Wiley's position to sponsor. He occupied an important official post in the Department of Agriculture, the arm of government obligated to foster interests of food producers, not consumers. Nevertheless, the Department of Agriculture did lend its indispensable and increasing support to Dr. Wiley's objectives—under a succession of administrations, of both major political persuasions. That could hardly have happened had not Wiley's supporters, in the Department and elsewhere, perceived the then obscure but now evident fact that consumer welfare is basic to prosperity of food producers.

Since 1906, the population of this country has increased 85%. Migration from the farm to the city increased the urban population by 140%. The change from an agricultural to an industrial economy made it necessary to supply city dwellers with food from distant areas. This accelerated a remarkable development of the food processing industries—and of food technology. The change in production methods and consumer habits has rightly been described as revolutionary. Thanks to improved techniques, new prcoesses and expanded distribution facilities, today's homemaker, rural as well as urban, has few of her grandmother's tedious chores. Much of the food she puts on the table comes ready to serve, or nearly so. She uses 12 times as many frozen vegetables as she did 15 years ago. Today, one-third of our coffee is the instant product; only 6 years ago the ratio was a scant one in sixteen. Frozen orange concentrate is a spectacular development.

The variety of processed foods has likewise multiplied many fold. A common estimate is that where less than 1,000 different articles were carried by an even well-stocked grocery before the war, the number today is likely to be between 4 and 5 thousand. Of prepared baby foods alone, unknown some 30 years ago, more than 80 different varieties are now marketed, with annual volume aggregating more than 150 million dozen containers.

These statistics are a tribute to accomplishments of the food technologist. They are gratifying evidence of public acceptance of the fruits of his effort. But let us not overlook the fact that public acceptance is based on public confidence. If that cornerstone of the food business structure is disturbed, economic catastrophe, to even whole segments of the industry, can result. The public is quick to react and to emphasize any doubt about what it eats. Consider how hard it has been to dispel the myth that "deadly ptomaines" lurk in canned food; how persistent has been the false notion that it is dangerous to keep food in an opened can; that oysters are poisonous in a month with no "R", or that various food combinations upset the digestion. Those are groundless fears. Recall, if you will, one that had some basis in fact—the ripe olive scare of the early twenties—and the staggering impact it had on that young industry, stunting its expansion for many years after the fault had been eliminated.

Progress means change—and the changes in the technology of food production have been coming thick and fast.

The new problems which seem always to accompany these changes have also been coming thick and fast. Outstanding among them are the problems constantly being raised by new chemical additives. This without any doubt is the most important mutual problem faced by food technologists and regulatory officials.

Too much of the discussion of this problem, in my opinion, is being carried on in broad generalities. The specific side of the problem was covered in the Delaney Committee hearings, but that background has tended to fade away in the intervening years.

I am constantly amazed by the variety and ingenuity of the new food additives. Take for instance the case of the banana paint. Not so many years ago stalks of bananas could be seen hanging in every grocery store. The grocer had a hook-shaped knife which he used to cut off the bananas. The big stalks came in bulky crates. One of the fruit companies conceived the idea of cutting off the individual hands of bananas and packing them in corrugated boxes, to save shipping space. But this raised the problem of a kind of spoilage known as stalk rot. A chemical paint was devised to seal the cut surface. Our question was—did any of the fungicidal chemical travel up the stem to contaminate the bananas?

Atomic research helped provide the answer. A radioactive tracer was added to the paint, but no detectable quantity could be found in the edible portion of the bananas. The process is now in widespread use.

Phytic acid, which is normally present in many foods, has been found to be useful in a dip to prevent discoloration of raw fruit and vegetables such as apples, potatoes, and lettuce. It appears to work by combining with certain trace elements, especially iron. But there was a nutritional objection to phytic acid. It tied up calcium, making this important element unavailable to the body. But by following the phytic acid dip with the calcium chloride dip, the objection was overcome—in fact calcium phylate itself can be used to prevent the discoloration. We did not criticize its use provided there was an adequate label statement.

Dimethyl dichloro succinate was tried experimentally as an ingredient in cheese wraps to prevent development of mold in prepackaged sliced processed cheese. Its use was abandoned after FDA chemists showed that it resulted in contaminating the cheese with measurable amounts of this toxic chemical. We have heard that a request for a tolerance for the material may be made. In the meantime, however, the cheese standards have been amended to permit the use of harmless calcium and sodium propionates and sorbic acid as mold inhibitors in sliced and cut varieties of packaged cheese. It remains to be seen whether additional preservatives will be needed.

Use of a colloidal silver solution for antibacterial effect in washing poultry, eggs, vegetables, etc., has been proposed. The contamination of food that could occur is very slight since the wash water would contain only one-tenth of a part per million of silver, or less. Nevertheless, we have opposed this on the basis that the toxic properties of this colloidal silver may differ

from those of ordinary silver. We would have to be satisfied on that point before we would withdraw our opposition.

Molybdenum disulfide has been used as a lubricant for food processing machinery, for example baking oven conveyors. This was originally questioned because of the knowledge that trace amounts of molybdenum in forage can be seriously toxic to ruminating animals. However, after it was shown that this so-called toxicity to animals was really a case of mineral imbalance, that the disulfide was virtually insoluble, and that it was tolerated in high doses in feeding experiments with rats, the objection to its use in food processing machinery was withdrawn.

An insecticide manufacturer would like to promote a new fly repellent for use on dairy cattle. However, since its toxicity has not been completely investigated, they are trying to develop data to show that the use would not result in contamination of milk. Our scientists have told them that their method should be sensitive enough to detect as little as one part of the repellent in ten million parts of milk.

A chemical company is working on some new propellants for pressurized food dispensers. The gas they are testing dissipates from foods so rapidly that animal feeding studies of toxicity are impractical. As an alternative the company is doing a series of inhalation studies.

A baking supply firm sells an anti-caking agent. On the basis of pharmacological data which have been supplied to us we are satisfied that the compounds used are not poisonous or deleterious, and we have not objected to their use in foods where such action was needed and where there was no conflict with the requirements of official standards.

These are only a few recent examples from the constant stream of questions and problems concerning food additives which are being presented by industry to our scientists and administrative officers. Increasingly the Nation's food supply comes in contact with a host of chemical agents serving a great variety of uses. Where these are of benefit to the public and have no possibility of harmful effect there should be no objection to their use. A high proportion of the proposals we receive fall in this class. But some of these chemicals have profound physiological effects, even in very small amounts.

We have estimated that there are about 400 chemical substances which are today being used for various purposes in food production. A recent report by the Food Protection Committee of the Food and Nutrition Board of the National Research Council shows that this is a conservative estimate. This report, incidentally, is a very good compilation of the various additives and their uses.[8] The additives now in use can be divided into three categories. About 150 are known to be harmless—that is, inert or innocuous. Another 100 are considered as safe within the limits of use—that is, in the quantities in which they are normally used. The remaining 150 are in a scientific no-man's-land—they are in use but have not been adequately tested. Our scientists do not know whether they are safe or not, but they suspect that some of them ought not to be in use.

Eleven bills are now pending in Congress to require the testing of new chemical additives for safety before they are put into foods. Hearings have been held by the House Committee on Interstate and Foreign Commerce, and I would say that these hearings have covered the subject very completely. There is general agreement that the law should be amended to require this pretesting. But there is disagreement about some of the details and procedure in the legislation.

A number of these pending bills contain "grandfather clauses" which would exempt from the testing requirements chemicals which are now in use—including the 150 which I mentioned above. There is no doubt that some kind of "grandfather clause" is necessary to exempt those additives which are generally known to be safe. It would be unnecessary and a hardship to require elaborate scientific tests to be conducted or repeated on such chemicals as vitamins, for example, on which we already have a wealth of pharmacological data. And there are others in this class.

The Department is on record, however, as opposed to any form of "grandfather clause" which would have the effect of exempting from the testing requirements chemicals which have not previously received the approval of the Food and Drug Administration or the Meat Inspection Branch of the U. S. Department of Agriculture, or which are not generally recognized by competent, expert authorities as safe for their intended use. This is the only position which we can take without being derelict in our duty to protect the public.

For half a century the Federal pure food law has been concerned with the addition of "poisonous and deleterious" substances to food. At first the law prohibited additives which "may" by any possibility injure any consumer. In 1938 Congress attempted to strengthen the law by prohibiting added poisonous or deleterious substances regardless of amount. It exempted only pesticides and other chemical poisons which are necessary or cannot be avoided in the production of food. This is the famous "per se" rule. Recently the Miller Amendment has provided an improved procedure for fixing safe tolerances for the residues of pesticides.

In the hearings on the chemical additive bills I testified that the Food and Drug Administration is willing to have this tolerance principle extended to food additives generally. This is actually a far-reaching step. It means abandonment of the per se rule and would be a modification of the necessity rule. It would mean that known poisons could be added to foods—in harmless amounts—provided that they serve some useful purpose in production or benefit the consumer.

This is a scientifically sound position. If safe tolerances can be established for pesticides they can certainly be established for other food additives. Many food components, naturally present as well as added, are poisons in large amounts but are beneficial in proper amounts. The per se rule was never a scientific one,

[8] *The Use of Chemical Additives in Food Processing.* A Report by the Food Protection Committee of the Food and Nutrition Board. Publication 398, The National Research Council. February, 1956.

and mainly on that account it has often been impractical of enforcement. To abandon it is a realistic step. Nevertheless, it is a far-reaching step. The food industries have made great technical progress under the per se rule. They have been able to utilize a large number of nontoxic additives. Now we are ready to have the door opened to a large increase in the number of possible additives, including some which must be used in carefully controlled amounts. Is it unreasonable to require that these be useful in some way? Let us remember we are not dealing merely with a wider marketing opportunity for chemical compounds.

The scientists tell us that because their tests are conducted largely with laboratory animals it is not possible to determine with complete certainty that chemical additives will be harmless to man. There is always a residual risk in permitting use of even small quantities of poisons in foods to be consumed by the young, the old, the sick, and the well. The Department believes it should be able to consider all the facts—the facts of usefulness as well as toxicity—when making the important decision whether to allow a toxic material in the Nation's food supply. When the material is not toxic we are willing to waive the criterion of utility. We would hope merely that the food industry will not immediately have a lot of those miracle ingredients that we hear about on television! It might become a little confusing—trying to tell the difference between the breakfast food and the toothpaste!

Now there is one more controversial issue on this chemical additive legislation. That is the question of procedure in regard to court review. The Department is on record as favoring the conventional type of court review, as set up in other sections of the Federal Food, Drug, and Cosmetic Act. We are opposed to the so-called declaratory judgment procedure in some of the bills. Under this procedure, if the Food and Drug Administration refused to clear a new chemical additive as safe the manufacturer of that chemical could go ahead and put it on the market, and the Government would have to try to stop him by filing a suit in a district court. In one of these declaratory judgment suits we would have to take part in what is known as a trial de novo—in other words, we would have to start from scratch and prove to that court or jury of laymen that the scientific testing done to show the safety of the chemical was inadequate for that purpose.

Certain lawyers and members of Congress, and some of the members of the chemical industries, are much in favor of this procedure. They feel it is needed to protect the manufacturer of a new additive from an arbitrary or bureaucratic decision by present or future officials of the Food and Drug Administration. As a matter of principle they feel that the conventional type of review of an administrative decision by a U. S. court of appeals is inherently biased in favor of the Government.

Our position is that scientific questions affecting public health should not be decided by such a factor as which side has the cleverest lawyer. Yet that is what may frequently happen if these complex scientific questions may be taken out of the hands of the scientists and put before our 251 Federal judges in 91 different districts for a trial de novo.

It is our view that the scientific question whether an additive has been shown to be safe for consumers should be decided initially by qualified scientists, and if there is any doubt, the doubt should be resolved in favor of the consumer. And it should be a single decision, establishing a uniform national policy.

I should not fail to point out here that the Federal judiciary sees the matter in much the same way as the Department and is on record as being opposed to the declaratory judgment procedure for handling scientific questions of this kind. Chief Judge Biggs of the Third Circuit Court of Appeals, came to the hearings on the bills representing the Judicial Conference of the United States and made a strong argument against including this declaratory judgment procedure in the chemical additive amendment.

I am not discouraged about the outlook for this legislation. The need for it is too great. Both consumers and the food industry need the protection which mandatory pretesting of chemical additives will provide.

III. CONTINUING COMPETITION IS THE GREAT INCENTIVE TO BETTER FOODS

Frank L. Gunderson, Ph.D., Technical Consultant, Washington, D. C.

WE MEN AND WOMEN who are active in food technology are happy to join the many others who are this year giving special recognition to the 50th Anniversary of two vitally important Acts passed by the Federal Congress and signed into laws by President Theodore Roosevelt on June 30th, 1906.

These are "The Food and Drugs Act, June 30, 1906" and "The Meat Inspection Act" of 1906. The first is administered by the Food and Drug Administration of the Department of Health, Education and Welfare; the second by the Meat Inspection Branch of the U. S. Department of Agriculture.

Today, on this Symposium Panel, it is my privilege and responsibility to speak from the viewpoint of one who has worked in various phases of food production and utilization. As a boy I was a farmer, in postgraduate years an assistant state chemist in regulatory work on feeds and fertilizers, and for more than 25 years a biochemist in nutrition, food research and development, and technical liaison.

Our food technologists play a role in agricultural production, pesticide controls, food processing, allied industries such as those providing the processing machinery, the sanitizing materials, the packaging materials, food transportation, warehousing, refrigeration and a host of related services. In research and development, in quality control, in production, and in top management, persons technologically qualified in chemistry,

chemical engineering, bacteriology, pharmacology, nutrition and other related sciences are busily engaged in a great variety of tasks essential to foods.

What parts of the two food laws relate most closely to food technology? The parts of the two laws of 1906 which probably relate most closely to the interests and responsibilities of food technologists are essentially these: *The Food and Drugs Law* is an Act for preventing the manufacture of adulterated or misbranded or poisonous or deleterious foods. The term "food" as used herein shall include all articles used for food, drink, confectionery, or condiment by man or other animals, whether simple, mixed, or compound. The examinations of specimens of foods shall be made in the Bureau of Chemistry of the Department of Agriculture.

The Meat Inspection Act of 1906, likewise signed into federal law on June 30th, 1906, related to all cattle, sheep, swine and goats to be slaughtered and the meat and meat food products to be used in interstate and foreign commerce. The carcasses and parts thereof of all such animals found to be sound, healthful, wholesome, and fit for human food shall be marked, stamped, tagged, or labeled as "U. S. Inspected and Passed"; conversely, all carcasses found unfit for human food shall be marked "Inspected and Condemned" and destroyed to avoid their use for foods.

Several extra comments about this Act may be in order. As you know, about 80% of all meats carry the stamp of approval. Other meat sold commercially is processed under State or local supervision. The Meat Inspection Act of 1906 immediately brought about public confidence in the safety, quality and wholesomeness of products carrying the meat inspection legend. This increased public confidence may be the greatest contribution of the Meat Inspection Act of 1906 to the Meat Industry.

Excellent teamwork is responsible for overall good results. Throughout the fifty-year span of the two food laws whose anniversary we commemorate, many men and women who were and are essentially food technologists have helped make both the spirit and the letter of these laws a part of our national policy. With almost no exceptions our raw agricultural products and the great assortment of simple and complex processed foods are free of harmful, deleterious or poisonous substances. Food technologists are grateful for the wisdom, and the persistent crusade, waged by the great Dr. Harvey W. Wiley, and to the nation's legislators for the laws providing the principal guideposts and the assignment of authority to make operating regulations. Also, we have great respect for the very competent, diligent, and conscientious members of the official agencies concerned. They have earned a very enviable record for their fairness to the regulated industries and their public service to all people as consumers. Equal recognition is deserved by food and allied industry leaders who have devoted their effective efforts so consistently to finer foods. Without the sustaining support, cooperation and encouragement by management in the food and allied industries, food technologists of the industries could not have accomplished their part toward the high purity, nourishment value, organoleptically attractive characteristics, storageability and the safety which typifies the foods throughout this great nation.

By whom and in what organizations are tests of safety made? The scientific tests on either established or new additives, or on the results of changes in processing methods, to evaluate and assure safety are made by laboratories of numerous types. These tests include chemical, bacteriological, pharmacological, microscopical and other examinations. These studies are made in the laboratories of the food, chemical, and allied industries themselves; in commercial and consulting laboratories; in universities and colleges; in research institutes and foundations; in the laboratories of states and in the laboratories of the Federal Food and Drug Administration. The FDA, with its limited budget, facilities and staff can itself conduct only a small fraction of the scientific studies it knows are needed.

Fortunately for all concerned the FDA encourages everyone with a legitimate purpose to come to Washington and to discuss proposed methods or experimental plans with them in advance, and then in due course to send the results to the FDA or come in personally to review results together. As a member of the Institute I strongly urge my fellow scientists and technologists to operate in a direct, sincere, candid, forthright partnership with the scientists of the FDA and the MIB. In most cases you should and can expect to receive an official opinion which is reasonably definite and mutually convincing. A minority of cases will be doubtful, controversial or dependent on further study.

FDA staff members have recently revised the series of articles entitled "Procedures for the Appraisal of the Toxicity of Chemicals in Foods, Drugs and Cosmetics." This extremely useful information is published in the October 1955 issue of the *Food, Drug and Cosmetic Law Journal*. Food technologists will find that excellent series of articles very useful, and we are deeply grateful to the FDA for the reports.

A debatable feature in food law affecting food technologists. In my judgment, and as contended by some others, the establishment of official Definitions and Standards of Identity of foods may tend to discourage expensive, long term research and development which otherwise might lead to improved forms and composition of those foods. To me, there is no doubt the incentive for new creations is thus reduced with respect to standardized foods. The temporary permit procedure, however, along with the Hale Act, and a more sympathetic administrative policy give promise of partially lessening this influence. If nationally standardized versions of certain foods were best for consumers, then surely the system reduces the elements of variation. However, consumers seem to relish new and different foods, and I believe we should all participate in providing still greater variety, attractiveness, and nourishment values in foods. Therefore, I do not regard the principle of Standards and Definitions has yet been proven sound.

Another point, ingredients usually need not be declared on the label of foods for which there are definitions and standards of identity. Despite the fact that

optional ingredients of standardized foods are open to public knowledge, one might raise the question whether the welfare of the consumer is served by non-disclosure on the label of the ingredients. One can readily imagine the dilemma of medical practitioners dealing with food allergies, and that of their patients, coping with mixed foods of which the labels do not disclose the ingredients.

While speaking of food definitions, standards of identity, temporary permits, general rules and policy, I regard it important also to call your attention to the convenient consolidation of these rulings all combined in Part II of the Federal Register, December 20th, 1955. Here again the FDA has done a fine service for our mutual convenience.

An illustration of excellent advisory service. The Food Protection Commitee of the National Research Council, as a group of scientific experts, serves a role of great importance to industry, to the government agencies and especially to the public. The FDA and the MIB look to the Food Protection Committee for formulation of basic guiding principles and occasionally for advisory opinions on specific classes of compounds. An example is that of artificial sweeteners.

The Industrial Liaison Panel and its executive group called the Industry Committee (of the FPC) brings the technologists of nearly 100 contributing food, chemical, food packaging, and allied industries into continuing direct contact with members of the FPC and its subcommittees and with scientists of FDA and MIB. The very gratifying feature is that those scientific meetings avoid specific proprietary questions. Rather, they consider broad basic guiding criteria, methodology, and fundamental principles. All of these are discussed in the informal atmosphere of the scientific seminar. The results seem mutually gratifying. This operation, now in its 6th year, deserves increasing participation by food technologists. Very definitely, it is a relevant and important part of multi-lateral understanding and mutual confidence in food safety. I believe other members of the IFT will agree heartily with me in giving tribute to the FDA and MIB scientists and administrators who have often requested the participation of the FPC and its affiliated committees.

How well have we all succeeded? what is our present status? are we headed in the proper direction? In conclusion, food technologists can justly share with those in agricultural production, in food processing industries, in our legislatures, and with our regulatory administrators and technologists, a feeling of gratification that we have steadily made foods finer in quality and highly safe. We owe our growing population every iota of good performance we can muster and from that course we must never falter. Fortunately, I do not know of a single food technologist who is complacent or who believes there is less opportunity for worthwhile achievements in the next fifty than in the past fifty years.

There are several aspects of the laws, regulations and policies that may not stand the test of greater time. For example, the concept behind the official requirement of the word "nonnutritive," now meant to be a warning or perhaps it is meant to be a stigma, may instead come to possess real positive virtue.

If, for example, more consumers desire a greater variety of low-calorie, but high bulking foods, then food technologists will vie with each other to formulate such foods. The incentive to be the first processor with the best, will be very great.

If there is sound reason favoring and safety in the readjustment of the amino acid balance in our diets, we do not want undue rigidity in regulations to stop that progress.

Again, if it becomes evident, for example, that either the amount or the specific kinds of fats in our diets should be changed to curtail cardiovascular diseases, then let us all together make sure that our laws, regulations, our means of communication and our understanding of each other, and our dedication to the best interests of the consumer give us the adaptability we need to meet newly recognized requirements.

We should not, and we must not, fence ourselves in with stifling laws and regulations. We need the maximum continuing incentives to stimulate individual creativeness. With effective incentives, the health, pleasure, freedom of personal choice, the safety and welfare of consumers will be most generously fulfilled.

IV. THE A.O.A.C. AND THE FOOD AND DRUG LAWS

Henry A. Lepper, Division of Food, Food and Drug Administration, Department of Health, Education, and Welfare, Washington 25, D. C.

ON JUNE 30, 1906, PRESIDENT THEODORE ROOSEVELT signed "AN ACT For preventing the manufacture, sale, or transportation of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines, and liquors, and for regulating traffic therein, and for other purposes." While this strictly legal title encompasses the principal objectives of the law, it gives the layman no ready concept of the importance of its provisions as they relate to direct public protection. However, it needed no catch-phrase title. The public was well aware of its significance after having witnessed the controversy which centered around the issues involved between those who regarded such legislation as interference with the rights of business and those to whom a paramount need was evident for correcting the abuses existing in the marketing of foods and drugs. The public saw the unfolding of the legislative drama and became so conscious of its importance that even before its passage the Act became popularly known as the "Pure Food Law." In further reflection of its provisions, its cumbersome title was immediately replaced by the more meaningful name, the Federal Food and Drugs Act, in all official activities. This law and its companion, a law to which Congress gave no title

but which has become established as the Meat Inspection Act, have been widely regarded and repeatedly acclaimed as of precedent-shattering impact as direct public protection measures.

The AOAC and its historical position. At this 50th Anniversary of the passage of these laws much is being said and more, perhaps, is being written about the contributions of individuals and groups as influencing the successful culmination of the legislative effort. With respect to the Association of Official Agricultural Chemists, the questions arise as to what influences that Association extered toward the passage of the law, what have been its activities during the 50 years of its enforcement, and what may be its functions in the years to come. In evaluating the Association's influence, one must fashion conclusions from the happenings of the time, much after the manner of the historian. The Association, being composed of officials many of whom were engaged in the enforcement of State laws designed for consumer protection in the purchase of fertilizers, feeds, foods, and drugs, might be expected to have become fervently active in support of national legislation for fuller control of foods and drugs. There is no evidence in the record that it did so. At the 1895 meeting a committee on pure food legislation was appointed to consider supporting a national law. Two years later the committee recommended that the Association urge upon Congress the passage of a pure food law of broad scope, based on the authority of Congress over interstate commerce, and the support of the Brosius bill (HR 5541, Fifty-fifth Congress). It is not specifically stated in the proceedings that the committee's report was approved. From its wording and the absence of disapproval, it is to be assumed that it was approved. At the meeting in 1900, a resolution was approved urging upon the Congress the passage of a re-introduced Brosius bill, HR 9677, and its companion measure in the Senate, No. 2222. The conveyance of the resolution to Congress seems to complete the extent of the Association's activity in this respect. This was six years before the final passage of the law, the anniversary of which is now being celebrated. There is nothing in the record to show any further activity in the intervening six years, during which time the controversy over the law became most heated. There is an indication that the Association may not have engaged in wider and continuing activity because many of its leading members were active in other capacities in support of passage of the law. Further, the Association was dedicated to science, and it may be that its devotion to that function precluded activities that might have been regarded as being dominantly political in nature.

As is often the case in controversies involving conflict of interests wherein those of the public are involved, a leader arises who by sheer ability and dedication to the cause inspires support in such numbers and from such diverse sources that the demands of public interest cannot be denied. During the period prior to 1906, in the fight for the pure food law, all who now recall the events of that time—and even those of this latter age who only by acquired knowledge have come to know—know that such leadership rested on Dr. Harvey W. Wiley. He was truly the champion of the consumer in matters relating to the purity of foods and drugs and their truthful labeling.

Extensive investigations were conducted under the direction of Dr. Wiley in the U. S. Division of Chemistry, with which the work of the Association became oriented because Dr. Wiley was equally a leader in the Association. His activity is first recorded in 1884 at the Atlanta meeting of agricultural chemists. This group had attempted to establish methods of analysis of fertilizers which would be equally acceptable to the official enforcement chemists and to those in industry. The failure to do so led directly to the formation of the Association of *Official* Agricultural Chemists in 1884 at Philadelphia, an activity in which Dr. Wiley took a foremost part. He is the only member who has the distinction of having attended every meeting from that time until the 28th annual meeting in 1911, the year preceding his resignation as Chief of the Bureau of Chemistry. His high regard for, and continued interest in, the Association was exemplified by his attendance at every subsequent meeting until the year before his death. During his membership he served as Secretary for 23 years. The record of events during those years shows the leading part he played in the direction of the Association's work and progress. The record is replete with reports made by Dr. Wiley on the scientific aspects of all phases of its work, and shows as well his prominence in directing the administrative procedures. In present day parlance, he would rightfully have been regarded as "Mr. A.O.A.C."

The influence of the Association on the passage of the food law was not restricted to the adoption of a formal resolution. The important contribution, although of less public appeal and notice, was its work on methods supplemented by its promulgation of standards for foods. The development of the practices of replenishing the soil by the addition of fertilizers led to the enactment by the several States of laws requiring the declaration on the label of commercial products of the quantities of the three elements essential to plant growth — namely, potash, nitrogen, and phosphorus. The knowledge of the facts upon which the fertilizer industry was established was the result of chemical investigations. The methods employed were those devised by individual researchers. In their development no care was taken to assure that the methods used could be as readily applied by chemists in general as by the investigator himself. They did not meet the needs of both the industry chemists in declaring the constituents and of the regulatory chemists in checking the accuracy and truthfulness of the declaration. Methods suitable for law enforcement must be so worded as to be so understandable that any qualified chemist can follow the directions and obtain accurate results of the same magnitude that others obtain when analyzing the same product. From the very beginning, before a method was adopted by the Association, proof of its uniform workability by concordant results in the hands of collaborating chemists was required. In speaking of the Association's system of collaborative study, Dr. Wiley, in an address at the third convention in 1886, said:

> " . . . The patient and laborious work which alone can give a solid basis for the business of this association must be done in our laboratories and repeated until it gives a sufficient proof of its accuracy. Happily the methods adopted by our committees secure the accomplishment of this work in the most thorough manner, and I doubt whether any other such system of determining the value of any analytical methods is practiced any where else in the world."

The AOAC and consumer protection. This Association, at the time its members were engaged in enforcing the fertilizer laws, was perhaps the first organization which had consumer protection for its inspiration. True, it was a restricted consumer group—the farmers. Within three years of the founding of the Association, the needs of the same consumer group were again recognized by the adoption of methods for the analysis of feeds. As with fertilizers, commercial feeds could be of little value without legal control of composition based on analysis. The availability of methods shown to meet the test of reliability required in law enforcement led to the passage of state laws controlling feeds. Connecticut, in 1895, was the first state to pass a feed law. This started a parade of state laws, and year by year one state after another was added to the list until by 1921 thirty-four states had passed such laws. Control of animal feeds was also provided in the Federal Food and Drugs Act of 1906.

The work of the Association which had consumer protection as one of its guiding principles would be expected to reflect the numerous attempts by Congress to enact legislation on food during the 27 years before 1906. This assumption finds support, for the Association adopted methods for dairy products in the same year as for feeds, to be followed the next year by methods for sugars and for fermented liquors. The extensive investigations on foods being carried out during these formative years in the Division of Chemistry in the U. S. Department of Agriculture under Dr. Wiley's leadership resulted in a publication, in ten parts, on "Foods and Food Adulterants," which became the famous Bulletin 13. The chemists conducting the investigations were all members of the Association, and the development of methods in the Division and in the Association went hand in hand. The availability of methods of analysis made possible the establishment of the composition and characteristics of genuine authentic foods to provide interpretative bases on which to demonstrate the adulterations being practiced on many foods when analyzed by the same methods. Thus was speculation removed from, and factual support given to, testimony before legislative bodies on the necessity of controls over food adulterations.

The Federal law of 1906, as it passed the House of Representatives, included a provision for the promulgation of standards for foods which were intended to be guiding upon courts of law in cases arising under the Act. Political maneuvering eliminated this feature, although the Congress several years prior to 1906 had authorized the Secretary of Agriculture to set up standards for foods with the cooperation of the Association as the authoritative body with knowledge of the composition of foods. The importance of standards was so well recognized that after the passage of the law the Secretary of Agriculture promulgated the standards of the Association as guides in the enforcement of the law. Through the years up to 1938, many additional ones were adopted, as recommended by a committee which included three representatives from the A.O.A.C. In 1938, the handicap to enforcement through the lack of legal status of advisory standards, long recognized, was finally corrected by a provision in the Federal Food, Drug, and Cosmetic Act establishing a formal procedure of standard-making resulting in standards accepted by the courts as authoritative and binding.

In cases under the food law, in most instances, the condition of the goods before the court on which the charges of violation depend must be established objectively by analysis. No greater confusion, perhaps, can enter the conduct of a case than questions arising on the suitability or accuracy of the methods of analysis employed. Argument over methods leaves a layman jury uncertain as to where the truth lies, and at times has confused judges, who by training and experience might be expected to be adept at bringing order out of chaos. The enforcement official should therefore use methods established as authoritative and accordingly regarded as the most suitable by all concerned. They must be such as give comparable results in the hands of all qualified analysts. It has been the contribution of the Association to provide such methods in increasing numbers through the 50 years of food law enforcement.

The Association provides a meeting ground where official and industrial chemists combine forces in a purely scientific environment to establish the most workable method for any given determination, suitable to both groups. The methods studied are not restricted to those perfected by official scientists. Methods originating in industry are frequently adopted after their worth has been established.

New developments will require new methods. Although the law of 1938 was hailed as a marked advance over the law it superseded, it has already been the subject of numerous amendments. It is to be expected that as technology advances in industry, new problems will arise. During the past fifty years a revolution in food production, manufacture, processing, preservation, and marketing has been coincident with a change from home production to industry preparation of countless foods. As widespread as this change-over may have been, it is no idle speculation to predict that the future years will see even greater advances. Industry—aside from that primarily engaged in food and drug manufacture—is offering countless substances and many new processes to the food and drug industry which by their use may come within the scope of the law, or, if not, will doubtless bring about further amendments. To meet the new problems which will inevitably arise will require newer methods if law enforcement is to keep abreast of its responsibility of consumer protection. To assure continued successful

enforcement, so long as present practices in the American courts continue or unless the law is drastically changed, the present requirements of acceptability for methods will apply to those yet to be developed. Thus will this Association continue the establishment of acceptable methods — a service to which it has been dedicated.

ADDENDA

Detailed discussions of the various phases of A.O.A.C. work may be found in the following references:

"A.O.A.C. Methods of Analysis," W. B. White, Food Drug Cosmetic Law Quarterly, Dec. 1946, p. 442.
"The Role of the A.O.A.C. in the Passage of the Federal Food and Drugs Act of 1906," William Horwitz, Food Drug Cosmetic Law J., 11, 77 (1956).
"The Development of Analytical Methods through Collaborative Effort," H. A. Lepper, Quarterly Bull. Assoc. Food & Drug Officials, 13, 122 (1949).
"The Evolution of Food Standards and the Role of the A.O.A.C.," H. A. Lepper, Food Drug Cosmetic Law J., 8, 133 (1953).
"Methodology," H. A. Lepper, J.A.O.A.C., 36, 30 (1953).

Objective Measurements of the Maturity Of Raw and Canned Field Peas, *Vigna Sinensis*[a]

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FIELD PEAS, *Vigna sinensis*, are purchased as the raw product and graded as the canned or frozen product *(4, 21, 22)* almost exclusively on the basis of subjective appraisal. The main purpose of this study was to ascertain whether certain objective tests used for quality control purposes for other vegetables might be used successfully to estimate the maturity and grade of raw and canned field peas. A secondary objective was to determine whether the gelling of canned field peas is associated with maturity. Like canned soybeans *(14)*, the liquor surrounding the peas occasionally forms a gel.

Makower *(18)* has reviewed most of the tests in use and proposed prior to 1950. Since that review, several additional studies dealing with the objective measurement of some attribute of raw or canned vegetables as related to organoleptic qualities have been reported. Among these, a few have dealt with field peas. Hoover and Dennison *(6)* found that the specific gravity of blanched and unblanched peas and the refractive index and the specific conductance of the liquid pressed from raw peas each was correlated with maturity. These same workers determined the moisture, protein, alcohol-insoluble-solids (AIS), starch, total sugar, and reducing sugars content of California No. 5 blackeye pea at six stages of maturity *(7)*. Percentage moisture, AIS, and starch were each highly correlated with maturity. The composition of field peas has also been reported by Wade *et al. (23)*, though not particularly with reference to maturity. Jenkins found that moisture, AIS, and alcohol-soluble solids of field peas remained unchanged for two days following harvest when the peas were not refrigerated and for six days when the peas were refrigerated *(9)*. Cain *(2)* studied the influence of storage time and temperature prior to canning on the tenderometer reading, drained weight, free starch and color of canned field peas. Stephens, Lime, and Griffiths reported that the Tenderometer, when properly calibrated, could be used to determine the maturity of blackeye and purple hull peas *(20)*.

EXPERIMENTAL METHODS

Raw, unshelled peas were secured from two growing locations in the State. During 1953, Dixie Lee, Purple Hull, Brown Sugar Crowder, and Calva No. 3 varieties were grown for this study at Midville and at Athens, Georgia. During 1954, Dixie Lee, Purple Hull, Louisiana Purchase, New Era, Blue Goose, and Mississippi SI varieties were grown at each of the locations.

Raw peas were separated by visual inspection into 3 stages of maturity. Separation was based primarily on the color and textural characteristics of the hulls. The first stage consisted of peas, the hulls of which were of a bright green color and a firm texture. The peas themselves were small, green, and immature. The second stage consisted of somewhat larger peas, the pods of which were a lighter green or which had brown as well as green areas. The peas were succulent, maximally-developed or nearly fully-grown, and the color ranged from a bright green to a very light green. The third stage consisted of peas, the hulls of which were devoid or nearly devoid of green color. The peas were usually devoid of green color and many had begun to dry.

Peas were shelled in a Dixie Junior Pea Sheller. Peas of the first stage of maturity were shelled by hand because the beaters did not knock the peas from the pod. Usually determinations were made immediately after shelling. When all the determinations could not be made at once, the peas were stored in closed jars at 32-33° F.

Moisture, starch, and AIS determinations. Moisture determinations were made by the vacuum-oven method of the A.O.A.C. *(1)* and by infra-red drying. For the infra-red method, the field peas were first chopped in a food chopper. Then, five grams of chopped peas were weighed out and spread in a thin layer in a tared open Petri dish and placed 7 inches below a 250-watt infra-red bulb in a closed cabinet. They were subjected to infra-red heating for 20 minutes, cooled in a desiccator to room temperature, and weighed. The AIS and starch content of the peas were determined by the A.O.A.C. methods *(1)*. The acid hydrolysis method for starch was used. Attempts were

[a] Journal Paper No. 15, College Experiment Station, College of Agriculture, University of Georgia, Athens. Some of the data are drawn from the Master's thesis of Henry R. Malcom submitted to the Graduate School, University of Georgia, August 1955.

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made to use the starch method of Nielson *(19)*, but results were too erratic to be satisfactory.

Penetrometer tests. None of the standard instruments for measuring maturity, such as the Tenderometer, were available. The Agricultural Engineering Department of the University of Georgia built a small penetrometer-type instrument which measured the force required to puncture a single pea with a hardened steel wire 0.1989 cm. in diameter. The penetrometer wire was driven at a relatively constant rate by a crank-drive screw. The pea nestled in a small cup which prevented it from moving. Penetrometer determinations were made on raw, blanched, and canned unskinned peas.

Extraction of juice from raw peas with pressure. To determine whether any relation existed between the percentage of liquid which could be expressed from raw peas and the maturity of the peas, the peas were subjected to 6,000 p.s.i. in the "wet-dry" mold of a Carver press, and the loss of weight measured by weighing the press cake.

Measurements on the canned product. Drained weight of the canned peas was determined in the conventional manner using a two-minute draining period. Moisture of the canned product was determined by weighing out the peas and the liquor for the moisture sample in the same proportion as the drained weight measurements showed the liquid and solids portions to exist. Density of peas was determined by the method of Holmquist, *et al. (5)*. AIS was determined according to the A.O.A.C. *(1)*. Viscosity of the liquor on the canned peas was measured with a Hoeppler falling-ball viscosimeter at $20° \pm 0.25°$ C. The liquor was pulled by means of a vacuum through a coarse, sintered filter prior to the determination and the liquor was warmed to 30° C. before being filled into the measurement tube of the viscosimeter.

Brine flotation. During 1953, raw peas at the 3 stages of maturity were floated in brines ranging in specific gravity from 1.01 to 1.19 to determine the percentage of each group which floated and sank in the different brines. During 1954, blanched peas were brine floated for the same purpose in brines of specific gravity from 1.08 to 1.14.

To establish whether brine flotation would be useful to separate peas of mixed maturity as well as to grade peas, lots of peas were taken between the blanching operation and filling in a commercial cannery and brine separated in a brine of sp. gr. 1.115. The peas were steam-blanched. Water-blanched peas of mixed maturity were also separated using a brine of sp. gr. 1.115 in the laboratory.

Sensory appraisal. The canned peas were evaluated organoleptically by a trained panel of 4 food technologists and 3 homemakers who were selected after a preliminary screening procedure. The peas were rated, using a hedonic scale, for flavor, texture, and color. Maximum possible score was, respectively, 12, 9, and 6 for each of the factors. Flavor, texture, and color were weighed differently because a series of preliminary panels indicated that the ultimate acceptability of samples depended primarily on flavor, secondarily on texture, and that color was of least importance. Five coded samples were evaluated at each session. Samples consisted of canned peas at each of the three stages of maturity, a commercially-canned field pea, and the fifth sample was a duplicate of some one of the other four samples. Canned floaters, canned sinkers, non-separated peas, a commercial sample, and a duplicate of some one of the foregoing were taste-tested in the same manner as peas at the three stages of maturity. The commercial peas were used to give, for the experimental lots, a reference point to a commercial product representative of present "good" practices.

RESULTS AND DISCUSSION

A highly significant correlation was observed between the stage of maturity of raw peas and each of the objective tests used. Mean values for moisture, AIS, starch, penetrometer values, and the percentage juice expressible under pressure are shown in Table 1 for each stage of maturity. Correlation coefficients are shown in Table 2. Although the penetrometer could be used to estimate the maturity of raw peas, the necessity of making several individual measurements to provide a fairly reliable average naturally limits the usefulness of such an instrument. Actually, the penetrometer was not used to establish its value alone, but, because none of the standard mechanical instruments *(3, 12, 17, 24, 25)* were available, the penetrometer was used to give an indication whether mechanical means of grading might be suitable. Since this study began, Stephens, Lime, and Griffiths *(20)* have shown that the tenderometer may be used to grade blackeye peas.

TABLE 1

Relationship of objective measurements to maturity of raw field peas harvested at three stages of maturity

Objective measurement	Stage of maturity		
	1	2	3
Moisture, %, 1953	76.4	65.6	29.4
Moisture, %, 1954	81.1	67.7	32.2
AIS, %, 1953	18.3	28.8	55.9
AIS, %, 1954	16.0	27.0	60.3
Starch, %, 1953	8.6	14.3	17.2
Penetrometer values, kg/cm², 1953	12.7	21.2	35.4[1]
Juice expressible at 6,000 p.s.i., %, 1954	22.9	18.6	2.2

[1] The maximum possible reading with the penetrometer was 35.4 kg./cm.². Whenever values actually exceeded 35.4, they were recorded as 35.4 kg./cm².

Determination of starch is even lengthier than that for penetrometer values; thus, this method too would not be satisfactory for quality control purposes. The fact that the percentage of juice expressible from the peas under pressure was correlated with maturity indicates that a succulometer type of instrument might be of value for the grading of raw peas *(15)*.

As may be seen from Table 2, either the moisture or the AIS content of raw peas was a good index of the maturity of the peas. The vacuum-oven method for moisture and the AIS method have an important disadvantage, both are time-consuming. Comparisons were therefore made between moisture determinations by the A.O.A.C. vacuum-oven method and the infra-red method previously described. In contrast to the A.O.A.C. method, the final results may be secured in about 35 minutes by the infra-red method. The infra-red method yielded values that averaged 1.32% less moisture than the vacuum-oven method. On the other hand, the infra-red method was less variable when replicate samples were compared. Application of the F test to the variance within replicate samples by the vacuum-

TABLE 2

Correlation of objective tests with maturity of raw peas

Comparison	r
Stage of maturity v. moisture, 1953	—0.779[1]
Stage of maturity v. moisture, 1954	—0.901[1]
Stage of maturity v. AIS, 1953	0.886[1]
Stage of maturity v. AIS, 1954	0.898[1]
Stage of maturity v. penetrometer value, 1953	0.928[1,2]
Stage of maturity v. starch, 1953	0.760[1]
Stage of maturity v. percentage juice expressible at 6,000 p.s.i., 1954	—0.815[1]

[1] Highly significant.

[2] The correlation coefficient is probably higher than the value shown because values for the third stage of maturity were recorded as 35.4 kg./cm² whenever the maximum range of the instrument was exceeded.

oven method and the infra-red method indicated that the infra-red method was significantly less variable. Though the two methods resulted in significantly different moisture values, the fact that the infra-red method yielded lower values is not particularly important inasmuch as a relationship could be established as readily between moisture and maturity by one method as by the other.

Brine flotation of raw peas was studied to determine first whether flotation would be useful as a grading tool and secondly to learn whether flotation could be used as a means of separating peas of mixed maturity into different maturity fractions as is done in the brine flotation of English peas, *Pisum sativum (16)*. Flotation was of little value for either purpose when raw peas were used. Our results were similar to those of Stephens, Lime, and Griffiths *(20)* who reported that brine flotation of blackeye peas was impractical because of air entrapped in the peas and those of Hoover and Dennison *(6)* who reported that air bubbles clinging to the surface of the peas buoyed the peas.

When the peas were blanched prior to flotation, results were more consistent. Usually, the percentage floaters fell along a straight line when the specific gravity of the flotation brine was plotted versus the percentage floaters on arithmetic probability paper. The data indicated that brine flotation could be of value in grading raw peas provided the peas were blanched and standards were established for each variety of pea.

Canned peas. Not only are objective tests needed to grade the raw product for maturity, but they are also needed for the evaluation of the grade of the canned product. Percentage drained weight, moisture content, AIS content of the peas and of the liquor covering the peas, the density of the peas, and the viscosity of the liquor are shown in Table 3. Correlation coefficients for each of the tests with maturity of the canned product are listed in Table 4. Although the percentage moisture and the drained weight of the peas varied with the three stages of maturity, these determinations would not be of much value for the grading of canned peas because canners could modify, with certain limits, the drained weight and moisture content, irrespective of the actual grade, merely by the length and method of washing, of blanching, and by changing the fill-in ratio of peas and brine. The percentage AIS of the canned peas was indicative of the stage of maturity of the raw peas from which the canned product was derived, but there are

TABLE 3

Objective and organoleptic attributes of canned field peas harvested at three stages of maturity

Test	Stage of maturity		
	1	2	3
Drained weight, %	68.2	72.8	99.9
Moisture content, %	85.8	80.3	70.2
AIS content, peas, %	14.2	20.3	24.6
AIS content, pea liquor, %	0.087	0.010	.....
Density of peas	1.049	1.071	1.116
Viscosity of pea liquor, centipoises	1.534	4.136	...
Flavor, score[1]	4.2	5.6	7.3
Texture, score[1]	6.4	5.9	4.4
Color, score[1]	3.2	3.2	2.9
Organoleptic evaluation, total score[1]	13.8	14.9	14.4

[1] Maximum score = 12, 9, 6, and 27, respectively.

TABLE 4

Correlation coefficients for certain tests made on canned peas

Comparison	r
Stage of maturity v. AIS content	0.720[2]
Stage of maturity v. density	0.555[1]
Stage of maturity v. viscosity	0.840[2]
Stage of maturity v. flavor score	0.623[2]
Stage of maturity v. texture score	0.595[2]
Stage of maturity v. color score	0.114
AIS content of fresh raw peas v. AIS content of canned peas	0.720[2]

[1] Significant.
[2] Highly significant.

limitations to the use of AIS values to establish the grade of the canned product. As Kramer and Hart *(13)* pointed out, AIS values cannot be used to distinguish between dry lima beans that have been stored before soaking and canning and dry lima beans soaked and canned immediately after harvesting. The AIS changes as a result of blanching and canning are shown in Figure 1. There was relatively little leaching of AIS materials from the peas into the liquor. The density of the peas was related to maturity. The viscosity of the liquor was likewise indicative of the three stages of maturity used. No values are listed for the third stage because the liquid was either gelled, or if there was free-flowing liquor, there was less than 30 ml., which amount is necessary to fill the falling-ball tube of the Hoeppler Viscosimeter. There is no doubt, however, that the viscosity of the third stage of maturity would be greatly higher than either of the other stages. In Figure 2, the relationship of the stage of maturity to

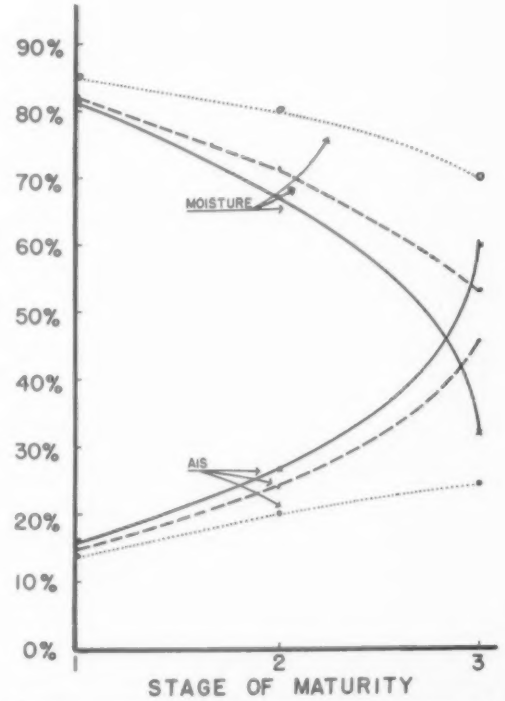

Figure 1. Changes in the moisture and AIS content of field peas as a result of blanching and canning. Solid lines, raw peas; broken lines, blanched peas; dotted lines, canned peas.

Figure 2. Effect of stage of maturity on the clearness of liquor and gelation of the liquor of four varieties of field peas. Peas in jars numbered 1, 4, 7, and 10 at first stage of maturity; in jars numbered 2, 5, 8, and 11 at second stage of maturity; in jars numbered 3, 6, 9, and 12 at third stage of maturity. Note distinct gelling of liquor in No. 6.

cloudiness of the liquor and gelling of the canned peas may be seen.

Brine flotation was useful to estimate the maturity of the canned peas when they were floated in brines ranging in specific gravity from 1.08 to 1.14. The percentage of canned peas which floated at each specific gravity level approximated a straight line when the specific gravity of the brines was plotted on the ordinate of arithmetic probability paper and the percentage floaters was plotted on the abscissa. The flotation curves for 6 varieties of canned peas are shown in Figure 3. For any one variety, there were usually distinct differences, at any one specific gravity level, in the percentage of floaters for each of the 3 stages of maturity.

The slope of the flotation curve also contributed information about the peas. The less the slope, the more homogeneous are the peas. If, for example, only 1-2% of the peas were to float at sp. gr. 1.09, but 98-99% of the peas were to float at sp. gr. 1.10, the shallow slope would indicate remarkable uniformity in maturity. Provided the peas are floated at three or more specific gravity levels and the samples of peas taken for flotation are representative of the entire can of peas, brine flotation may provide information about the homogeneity of the peas as well as give an estimate of their average grade. Makower *(18)*, in pointing out the limitations of brine flotation as a grading tool for English peas, stated also that brine flotation is the only objective test which gives an indication of the maturity of components of the sample rather than just the average maturity of the sample. She further pointed out that brine flotation and organoleptic appraisal are the only two tests which evaluate the maturity of individual peas rather than the average maturity of the sample. Thus, although brine flotation has well recognized limitations, it is of value where results must be obtained rapidly, as in grading or quality control, or where knowledge of the uniformity of maturity is desired.

As may be seen from Figure 3, sometimes one stage of maturity for one variety fell within the range of a different stage of maturity for another variety. This inconsistency may in part be a result of the fact that the stage of maturity was initially determined by subjective, visual judgment and may therefore represent an error in judgment rather than be evidence of a major varietal difference.

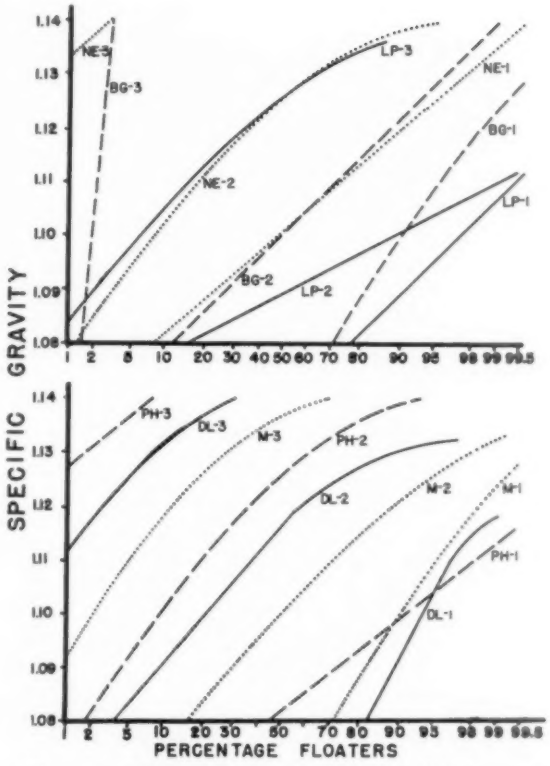

Figure 3. Relationship of the maturity of canned peas to the percentage of peas floating in brines of different specific gravity, plotted on arithmetic probability paper. Letter combinations BG, NE, LP, PH, DL, and M stand, respectively, for Blue Goose, New Era, Louisiana Purchase, Purple Hull, Dixie Lee, and Mississippi S1 varieties. Numbers 1, 2, and 3 following letter combination stand, respectively, for first, second, and third stage of maturity.

Organoleptic quality of canned peas. Organoleptic scores for the quality of the 6 varieties of canned peas are shown in Table 3. Peas of the third stage of maturity scored highest in flavor. The tenderness score tended to decrease as the peas increased in maturity. Although there were distinct differences in color among the 3 lots, color did not appear to govern acceptability to any great extent as the relatively close scores indicate.

Comparison of organoleptic scores with the stage of maturity has at least one serious disadvantage: one is merely comparing one subjective evaluation against another subjective evaluation, either or both of which evaluations could involve appreciable error. For that reason, organoleptic scores were also compared with the AIS content of each sample. When that was done, instead of flavor appearing to increase consistently as the maturity of the peas increased, it was noted that the flavor score dropped off above an AIS content of 26.5%. The relationship of AIS content to organoleptic score is shown in Figure 4. The flavor score was at a maximum from an AIS content of about 20% to

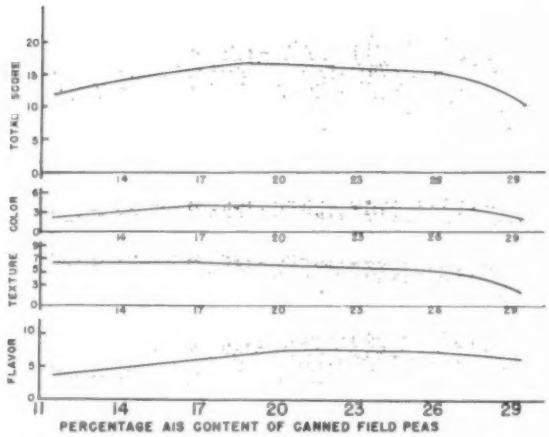

Figure 4. Scatter diagram showing relationship of AIS content of experimentally canned field peas to organoleptic score.

26.5% ; above that AIS level the score began to fall off. The texture score decreased slightly from an AIS content of 17% to about 26.5% ; then it decreased more sharply. The color score within the range 17-27.5% AIS remained practically constant. The over-all effect was that the organoleptic score was at a maximum and relatively constant from approximately 19 to 26% ; then it decreased quite rapidly from 26 to 29%, the latter figure being the upper limit of any of the samples studied. It may also be noted from the scatter diagram that the variance about the line would be rather high had the lines been fitted statistically instead of by inspection.

These observations are in line with those of Hoover and Dennison who found that the preference rating of frozen field peas generally was at a maximum at some point other than the youngest and oldest maturity stages they studied *(8)*. Woodroof likewise observed that very young peas or overmature peas were less desirable than green, fully-developed peas of an intermediate stage of maturity *(26)*. Kramer *(10, 11)* has discussed the use of multivariate regression analysis to establish the relative importance of color, texture, and other factors determining the grade of canned food.

Sensory score and the AIS content of the commercial peas, which were taste-tested at the same time as the experimental lots of peas, were compared in the same manner (Figure 5). Except for one can which had an AIS content of 17.2%, the AIS content of the commercial peas was in the range, 20.5-24.9%. Within this particular range the commercial peas scored lower organoleptically, the greater was the AIS content. Only general comparisons of the trends shown by the experimental lots and the commercial peas can be made because the commercial peas were given a less severe process than the experimental batches, and, of course, the peas and the canning procedure differed in other respects too. The two graphs of AIS content versus organoleptic score do suggest that palatability begins to decrease above a certain AIS level, but the limited data naturally are inadequate to indicate the maximum AIS content acceptable in terms of quality.

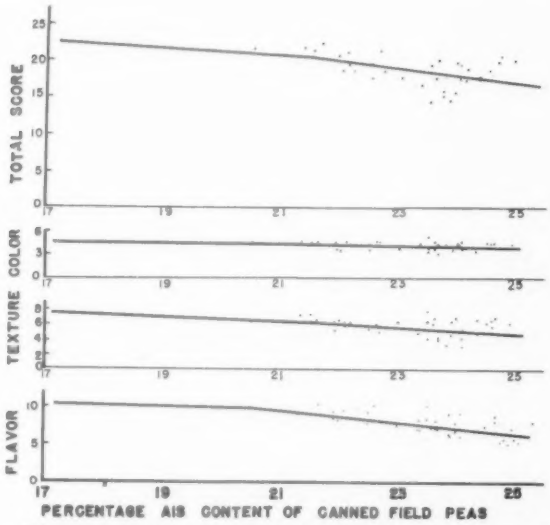

Figure 5. Scatter diagram showing general downward trend of flavor, texture, and total organoleptic score of canned field peas as AIS content of peas increased.

Brine separation. Brine flotation tests were made on peas of mixed maturity to determine whether floaters and sinkers separated in a brine of specific gravity of 1.115 would differ significantly. Various objective and organoleptic tests made on the canned peas are shown in Tables 5 and 6. Brine flotation of the peas appeared to separate the peas into distinct maturity fractions when the peas were judged by the objective tests, but the differences in the peas were not sufficient to lead to clear-cut differences in organoleptic quality. Results for the steam-blanched peas are shown in Table 5. Data for the water-blanched peas are shown in Table 6. Data for the water-blanched peas are more promising. The floaters of the most mature batch, Batch A, scored higher than the control and considerably higher than the sinker fraction. Results of Batches B, C, D, and E were combined because the AIS content of the four batches of blanched peas were about the same. The floaters were judged better than the control. The sinkers did not decrease in score, but it must be noted that at an AIS content level of 23.5% the sinkers are still well within the maximum-quality plateau evident in Figure 4. By the same token, the two batches of steam-blanched sinkers, having an AIS content of approximately 27%, might be expected to score lower than they did. The fact that they did not may be mere sampling variation since only two batches are involved and the variance about the AIS-Organoleptic score line is quite high. Furthermore, steam-blanched peas separated at a given specific gravity level might not yield the same results as water-blanched peas. Holmquist *et al. (5)* observed that the percentage of floaters varied at different salometer levels depending upon whether English peas were blanched in steam or water. At the specific gravity level used, no advantage could be attributed to brine flotation of the steam-blanched peas. Of the 5 batches of water-blanched peas separated, four of the floaters lots scored higher than the control and

TABLE 5

Control, floater, and sinker fractions of steam-blanched, brine-floated field peas

Determination[1]	Batch A			Batch B		
	Control	Floaters	Sinkers	Control	Floaters	Sinkers
Blanched peas						
Moisture, %	63.6	64.1	50.1	67.3	66.3	55.9
AIS, %	28.9	28.6	38.9	29.0	29.0	36.2
Canned peas						
Drained weight, %	81.1	76.6	88.5	80.8	75.2	75.2
Moisture, %	75.6	76.4	76.1	76.2	76.6	73.6
AIS, %	23.9	23.5	27.5	23.3	23.8	27.2
Density of peas	1.089	1.089	1.114	1.070	1.060	1.084
Viscosity of liquor, centipoises	6.453	5.095	8.666	5.701	5.409	8.889
Percentage floaters in brine,						
sp.g. 1.08	0	1	0	0	1	0
1.09	4	4	0	11	4	0
1.11	23	20	0	25	14	0
1.12	60	63	2	63	39	8
1.13	84	79	5	100	91	72
1.14	100	99	7	100	100	92
Flavor, score[2]	6.6	6.5	7.0	6.7	7.7	8.0
Texture, score[2]	5.0	5.2	4.9	5.8	5.8	5.8
Color, score[2]	3.6	2.9	3.2	3.8	3.7	3.7
Organoleptic evaluation, total score[2]	15.2	14.6	15.1	16.3	17.2	17.5

[1] Each value shown is the mean of four or more replicates.
[2] Maximum score = 12, 9, 6, 27, respectively.

in two instances both the floaters and sinkers scored higher than their corresponding control. The sinkers of these 2 lots had AIS contents of 23.1 and 23.2%, the lowest of any of the sinker fractions. Improvement in uniformity might be an advantage of brine flotation when the sinker fraction itself is not so mature as to be scored low organoleptically. The data do suggest that brine flotation may be of value in separating peas of excessive maturity and in improving the uniformity of grades.

SUMMARY

Either the moisture content or the AIS content of raw field peas, *Vigna sinensis*, were satisfactory indices of the maturity of the field peas. The starch content, resistance of the pea to puncturing by a penetrometer plunger, and the percentage juice expressible by pressure were also correlated with maturity.

Brine flotation of the raw peas was unreliable as a guide to maturity, but brine flotation of the blanched peas was sufficiently consistent to be of some value for the grading of peas. Brine flotation of peas of mixed maturity separated sinker and floater fractions which differed appreciably in their objective attributes, but they did not differ in all lots in organoleptic qualities.

The AIS content of the canned peas was highly correlated with the stage of maturity. Organoleptic acceptability initially increased as the AIS content increased; above an AIS content of approximately 26%, the palatability began to decrease as the AIS content continued to increase further.

Acknowledgments

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TABLE 6

Control, floater, and sinker fractions of water-blanched, brine-floated field peas

Determination[1]	Batch A			Batches B, C, D, and E		
	Control	Floaters	Sinkers	Control	Floaters	Sinkers
Blanched peas						
Moisture, %	65.9	66.0	56.3	72.7	71.4	59.3
AIS, %	32.1	27.4	33.5	22.5	22.1	31.4
Canned peas						
Drained weight, %	85.4	76.2	74.1	76.8	75.1	76.0
Moisture, %	75.6	77.4	73.1	80.5	80.2	74.1
AIS, %	22.3	20.8	25.8	18.7	18.1	23.5
Density of peas	1.088	1.081	1.108	1.068	1.074	1.112
Viscosity of liquor, centipoises	8.269	4.930	4.477	9.950	11.461	6.609
Percentage floaters in brine,						
sp.g. 1.08	0	1	1	4	3	0
1.09	0	1	0	12	10	1
1.11	5	3	0	61	48	2
1.12	14	10	0	85	78	10
1.13	41	54	5	97	93	23
1.14	65	87	8	99	99	57
Flavor, score[2]	7.4	7.4	6.3	7.1	7.3	8.1
Texture, score[2]	5.9	7.0	5.2	6.3	6.5	5.8
Color, score[2]	4.2	3.8	3.8	3.6	3.4	3.3
Total score[2]	17.5	18.2	15.3	17.0	17.4	17.1

[1] Each value shown is the mean of four or more replicates.
[2] Maximum score = 12, 9, 6, 27, respectively.

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Chemical Aspects of Pectin Gel Darkening[a, b]

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THE OCCURRENCE of a brown discoloration in model systems, simulating the sugar-acid-pectin fraction of fruit preserves, has been shown by Livingston, Pandit, Steinberg, and Fellers *(8)* to be related to sugar degradation. The present study was undertaken to isolate and identify the carbonyl compounds formed during the heat treatment of sucrose-citric acid-pectin gels, and citric acid-fructose solutions, to determine the roles of those compounds in the darkening of the gels.

EXPERIMENTAL

Preparation of the "standard gel." Composition of the gels used has been described by Livingston *et al. (8)*. Gels were prepared in a one-liter three-necked flask fitted with a mercury-sealed stirrer in the center neck, a water-cooled condenser in one side-neck, and a thermometer in the other side-neck. Most of the water was added to the flask, the temperature was brought to 180° F. (82° C.) by means of a heating mantle, and using a variable resistor, was held as closely to that temperature as possible throughout the preparation of the gel. The pectin, intimately mixed with ten times its weight of sucrose, was added to the water and was dissolved with stirring, after which the remainder of the sucrose was added. This solution was heated for a total of 50 minutes before the citric acid, which had been dissolved in an aliquot of the water, was washed into the flask. Heating was continued for 10 minutes after the addition of the acid. The solution was then transferred into lipless pyrex test tubes by means of a pipetting machine. Tubes were sealed in an oxygen flame.

Preparation of solutions. To determine the contribution of individual sugars and pectin to the formation of brown color in the standard gels, solutions of citric acid-glucose, citric acid-fructose, and citric acid-galacturonic acid were prepared. Concentrations of each of the constituents were the same as they would be in the standard gel, assuming complete hydrolysis of the sucrose and pectin with no further breakdown occurring, i.e., citric acid 0.5%, glucose 33.75%, fructose 33.75%, galacturonic acid 0.75%.

Preparation of ion-exchange columns. Aldehydes and ketones were separated from other constituents of the gels by means of ion-exchange columns using IRA-400[d] resin in the bicarbonate and bisulfite forms, according to the methods of Gabrielson and Samuelson *(4, 5, 6)*. For the removal of acids, the column dimensions were 10 x 140 mm. Since the resin, in the free base form, reacts with aldehydes and ketones as well as with acids, the column was used in the bicarbonate form; thus, only the latter compounds were retained. The column was prepared for use by passing through 400 ml. of 1 M sodium bicarbonate at a rate of two ml. per minute. It was then washed with water until the effluent showed no alkalinity, using phenolphthalein as indicator. The anion column, used for the removal and separation of aldehydes and ketones, had dimensions of 13 x 150 mm. It was used in the bisulfite form to take advantage of the property of these compounds to add bisulfite.

The column was prepared for use by passing through 500 ml. of 1 M sodium bisulfite at the rate of 4 ml. per minute. The column was then washed extensively with water until the effluent failed to decolorize a dilute iodine solution.

Fractionation procedures: removal of acids. First step in the fractionation of the solutions was the removal of the acids. This was accomplished by a combined operation in which the solution (25.0 ml. of a solution containing 20% solids) was added to most of the bicarbonate resin in a beaker and shaken for one minute. The mixture was then poured into the column, and the solution allowed to run through at the rate of 8 ml. per minute. The column was washed with 150 ml. of water and the wash water was combined with the solution effluent. When visibly brown solutions were fractionated, most of the color was observed to pass through the column.

Removal of sugars and separation of ketones from aldehydes. Combined effluents from the bicarbonate column were passed through the bisulfite resin at the rate of *2* ml. per minute, and the column was washed with 150 ml. of water. The effluents contained the sugars, carbonyl compounds being retained on the column.

Ketones were eluted by the addition of 100 ml. of water at 75° C., run through the column at the rate of *2* ml. per minute. The column temperature was maintained by recirculating water at 75° C. through a glass jacket surrounding the column.

Aldehydes were eluted by passing through 500 ml. of 1 M sodium chloride at the rate of *2* ml. per minute. The necessarily large dilutions made it impossible to detect visually the presence of color in these two fractions.

Separation of gels into acid, sugar, ketone, and aldehyde fractions. Prior to adopting the procedures described above for the elution of aldehydes and ketones, experiments were conducted to separate a gel heated for 300 minutes into acid, sugar, ketone, and aldehyde fractions suitable for spectrophotometric examination. Fractionation was conducted in essentially the same manner as already described, the difference being that the acids were eluted with 100 ml. of 1 M sodium carbonate collected at the rate of 1.5 ml. per minute. The column was washed with 100 ml. of water which was combined with the first effluent. Sodium ions were removed by shaking the solution with most of the hydrogen-form IR-120[d] resin from a cation column, until gas ceased to be evolved, at which time it was poured through the column, which contained several ml. of resin. Collection was at the rate of 7 ml. per minute. Washing was accomplished with 200 ml. of water.

Aldehydes were eluted with 500 ml. of a 0.075 M sodium carbonate-0.15 M sodium bicarbonate solution, and the eluate was freed from sodium ions in the same manner as the acid fraction. The dilute solutions were reduced in volume by lyophilization. Table 1 describes the appearance of the fractions from the gel heated for 300 minutes, as removed from the lyophilization apparatus in the dry or nearly dry state.

Preparation of derivatives. Instability of the aldehyde fraction as indicated by blackening during lyophilization (see Table 1), necessitated its stabilization by the formation of derivatives. For this purpose 100 ml. of a saturated 2,4-dinitrophenylhydrazine (DNP) solution, in *2* N hydrochloric acid, was added directly to the effluents from the bisulfite column. For these experiments, the gels used were heated 0, 20, 30, and 300 minutes at 230° F. (110° C.) These heating times were used because they produced a series of gels ranging from those presumably containing only the browning precursors, to those in which marked browning had occurred.

The DNP-gel solutions were allowed to react at 35° C. for approximately 12 hours, and were then stored in a refrigerator until used.

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[b] Contribution No. 1051, Massachusetts Agricultural Experiment Station. This paper reports on research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned No. 662 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsements of the Department of Defense.

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TABLE 1

Appearance of fractions, from gel heated 300 minutes, after completion of lyophilization

Fraction	Appearance
Acids	Individual amber and brown viscous droplets
Combined sugars, ketones and aldehydes	Light brown highly viscous liquid
Sugars	Colorless highly viscous liquid
Ketones	Flocks of white dry material
Aldehydes	Black viscous liquid containing some insoluble material

Preparation of volatile carbonyl compounds from heated gel and citric acid-fructose solutions. Volatile carbonyl compounds from both a gel and a citric acid-fructose solution were obtained by distillation. For this purpose, 896 g. of gel in a stoppered Erlenmeyer flask, fitted with a glass tube which led into an ice-cooled DNP solution, were heated for 3 hours at 245° F. (118° C.). A citric acid-fructose solution, weighing 1001 g., of which fructose comprised 63.74%, was treated in the same way.

Chromatographic separation of 2,4-dinitrophenylhydrazones. Preliminary attempts to separate the 2,4-dinitrophenylhydrazones (DNPHs), using the methods of Silberstein *(16)*, Stadtman *(17)*, and Rice, Keller, and Kirchner *(11)*, indicated that, in most cases, no single method was suitable for the separation of mixtures of such complexity.

Markakis *(9)* has successfully separated the anthocyanin pigments of strawberries by means of ascending paper chromatography, and this modified technique was used for most of the separations of the carbonyl derivatives. The mixtures, in ethyl acetate solution, were applied in streaks 2.5 inches from one end of 7.5 x 24 inch strips of Whatman No. 1 filter paper. The solutions were applied from a 0.2 ml. pipette whose tip had been drawn to a fine point. Excessive spreading of the solution was prevented by applying the air jet from a hand electric-drier to it as it was being applied to the paper. Papers were placed in chromatography jars, containing a suitable one-phase solvent which was allowed to ascend until it was evident that continuing the process would result in no further separation. The first solvent used was usually petroleum ether (B. P. 60-110° C.). This relatively poor solvent is effective in causing the migration of some aldehydes of lower molecular weight. After the petroleum ether-soluble material had been moved for a distance of some 25-30 cm., the paper sheets were removed, air-dried, and replaced in the chromatography jars with benzene or a mixture of benzene and petroleum ether as solvent. This procedure was continued, using increasingly stronger solvents, such as mixtures of benzene and ethyl acetate in varying proportions, until the original streak had been moved from its point of application. The separate bands were cut from the paper, eluted with ethyl acetate or methanol, in most cases, concentrated by evaporation under vacuum, and reapplied to paper sheets of the same size or narrower depending upon the amount of DNPH available. When bands could not be resolved further using these solvents, they were eluted from the paper, and the solvent allowed to evaporate slowly so as to induce crystal formation.

In addition to the above method, separations were made using column chromatography. Various adsorbents were tried, including: alumina, "neutral" alumina, "acid" alumina, anhydrous magnesium sulfate, calcium sulfate, talc, and silicic acid. Alumina was found to exhibit the best properties of the adsorbents tested. Using this material, columns were filled simply by pouring four or five centimeters directly into a pyrex tube one centimeter in diameter, and packing the adsorbent by gently tapping against the tube with a short length of rubber hose. No suction was necessary, either for packing or running the chromatogram.

Chromatographic identification of the DNPH of 2-hydroxymethyl-5-furaldehyde. The previously described method used for the separation of derivatives is not applicable to the purposes of identification because the single-phase solvent system precludes partitioning of the materials between two liquids. A two-phase solvent system was prepared using formic acid as the stationary phase, and a mixture of benzene-heptane (1.75 : 1) as the mobile phase. This solvent also moved bis-DNPHs such as glyoxal and pyruvaldehyde. The method used is as follows: formic acid is saturated with the benzene-heptane mixture by shaking in a separatory funnel. The layers are then separated and placed in petri dishes in the bottom of the chromatography jar, an aliquot of the hydrocarbon layer being reserved for later use. The papers, with the spots applied, are placed in the chromatography jars and equilibrated for 2 hours, after which time, the hydrocarbon layer is added to the troughs. The descending movement is rapid, and after approximately 3 hours the solvent front moves some 30 cm. at room temperature. On removal from the jars the papers are thoroughly air dried to remove the formic acid, or it will adversely affect the colors formed by the DNPHs when sprayed with ten percent sodium hydroxide. This method has the advantage that, by changing the ratio of benzene to heptane, the rate of movement of the DNPHs can be changed. Too rapid a migration, caused by excessively increasing the proportion of benzene to heptane, will cause the spots to streak.

RESULTS AND DISCUSSION

Effect of lyophilization on fractions from heated gel. On removal of the fractions of the gel heated for 300 minutes at 230° F. (110° C.) from the lyophilization apparatus, the sugar fraction was found to be the largest, as was to be expected. The acid and ketone fractions were very small, probably representing no more than a few milligrams each. The aldehyde fraction was approximately 5 ml. in volume, and no attempts were made to reduce the volume further. Acids and aldehydes were the only separate fractions possessing a color. The combined sugars, ketones, and aldehydes yielded a light brown syrup on lyophilization, but concentration of the aldehyde fraction resulted in extreme darkening which began immediately on the removal of moisture from the edges of the frozen fraction in the lyophilization flask.

Weights of derivatives formed from gels and solutions. Table 2 shows the weights of DNPHs formed from the aldehyde and ketone fractions of a gel and citric acid-fructose solution heated for 300 minutes.

It is significant that the fructose solution, which contained half as much sugar as the gel, yielded nearly three times as much aldehyde derivatives, and twice as much ketone derivatives, as did the gel. However, there was more color formed in the gel than in the fructose solution. Respective optical densities of the undiluted solutions, measured at 450 mμ, are 2.00 and 1.12. Thus, interaction of the breakdown products of all the components of the gel results in a greater degree

TABLE 2

Weight of 2,4-dinitrophenylhydrazones formed from the aldehyde and ketone fractions of gels and citric acid-fructose solutions heated at 230° F. (110° C.)

Material	Heating time (minutes)	Mg. of derivatives formed	
		Aldehydes	Ketones
Gel	0	0.1	0
Gel	20	1.4	0
Gel	30	3.9	0
Gel	300	104.8	3.3
Solution	300	296.6	6.9

of darkening than can be produced from the breakdown products of any of the individual sugars. These brown products, in the gel, probably polymerize in such a manner as to bind free carbonyl groups, and thereby preclude a reaction with DNP.

The rapid appearance and relatively high concentrations of aldehydes in comparison to ketones, together with extreme blackening of the aldehydes during lyophilization, as contrasted with absence of color in the dry ketone fraction, are strong evidences that the former compounds play the more important role in darkening of the gels.

Separation of aldehyde DNPHs from gels. DNPHs from gels heated 0, 20, and 30 minutes were separated into 42 bands on paper, none of which were in sufficient quantity to permit further work.

Derivatives from the gel heated 300 minutes were separated by combined column and paper chromatography into 395 bands, of which only nine yielded crystalline compounds in sufficient quantity for both melting point determinations and spectrophotometric examination.

Five additional compounds were obtained in the crystalline state, but quantities were so small that only spectrophotometric measurements could be made. Of the latter group, 4 compounds were yellow and had principal absorption maxima in the vicinity of 360 mμ. The fifth compound existed in red crystalline form, and showed a maximum at 380 mμ. According to Braude and Jones *(1)* and Roberts and Green *(12)*, saturated aldehydes DNPHs in ethanol absorb in the area 356 to 365 mμ, enals absorb at 366 to 387 mμ, dienals at 379 to 385 mμ, and trienals at 395 to 410 mμ. Silberstein *(16)* and David and Joslyn *(3)* have found that saturated aldehydes usually form yellow derivatives with DNP and unsaturated aldehydes form red derivatives. In addition, simple aldehyde derivatives usually form a red or red-brown color in alkaline solution, while the DNPHs of dicarbonyls form a blue color.

Spectra of the 4 crystalline yellow compounds indicated that they are saturated aldehydes. The ready mobility of these compounds in petroleum ether suggested that they are of low molecular weight. The fifth compound of this group, was mobile in benzene-petroleum ether (1.5:1). Its spectrum indicated that it was a simple unsaturated carbonyl derivative containing one or two double bonds. When spotted on paper and sprayed with 10% sodium hydroxide these, and all other compounds isolated in crystalline form, displayed a red color, confirming that they were derived from simple aldehydes.

Data concerning the 9 compounds whose melting points were obtained, are summarized in Table 3. All melting points were determined using a Fisher-Johns apparatus. Melting of the crystals was observed under a dissecting microscope. The melting point of compound IIf (87-89° C.) is low and in the range for the DNPHs of simple aldehydes derived from 8 to 12 carbon primary alcohols. Its saturation is confirmed by its absorption maximum at 360 mμ. Compounds IIa and IVb are enals or dienals, as indicated by their color and absorption maxima. Compounds IIb, IId, and IVa are dienals, and compounds IIc and IIe are either dienals or trienals.

TABLE 3

Physical data of 2,4-dinitrophenylhydrazones obtained in sufficient quantity for melting point determinations from gels heated 300 minutes at 230° F. (110° C.)

Fraction	Developing solvent	Color of crystals	Melting point (° C.)	Absorption maximum (mμ)
IIa	Pet. Ether-benzene (8:1)	red	193-194	380
IIb	Pet. Ether-Benzene (1:1)	red	188	389
IIc	Benzene-Pet. Ether (2:1)	red	239-240	395
IId	Benzene	red	210-211	392
IIe	Benzene-Ethyl[1] Acetate (9:1)	red	206-208	395
IIf	Benzene-Ethyl Acetate (9:1)	Yellow-orange	87-89	360
IVa	Pet. Ether-Benzene (2.5:1)	red	217	390
IVb	Pet. Ether-Benzene (2.5:1)	orange	179-182	381
IVc	Pet. Ether-Benzene (1:1)	red	198-199	389

[1] From silicic acid column.

The absorption spectrum and color of compound IVc indicated that it is a dienal. Its meltting point of 198-199° C. corresponds with the values for the DNPH of 2-hydroxymethyl-5-furaldehyde (HMF) of 198-200° C. as found by Scallet and Gardner *(14)* and 197-198° C. as reported by Wahab *(18)*. When the spectrum of this compound was compared with that of pure HMF, prepared by the method of Haworth and Jones *(7)*, it coincided closely as shown in Figure 1. The identity of this compound was further established by chromatographing this compound together with DNPH of pure HMF applied to the paper as both combined and adjacent spots. The combined spot

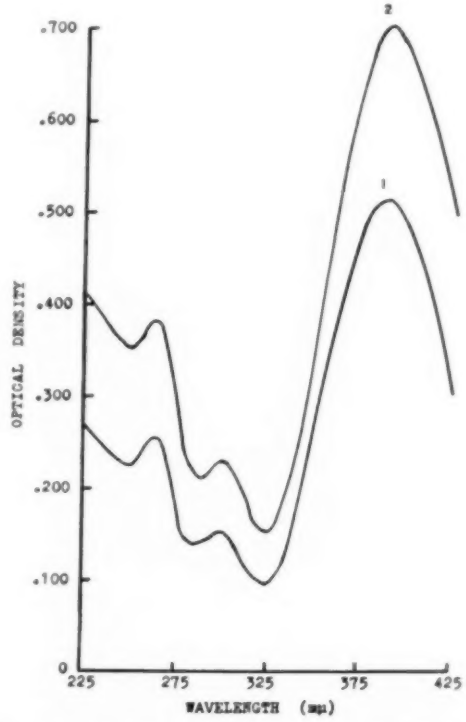

Figure 1. Absorption spectrum of dinitrophenylhydrazone of HMF:
1. DNPH of pure HMF
2. DNPH of HMF from heated gel

moved as a unit, and the unknown had the same R_p of 0.31. (The symbol R_p is used to indicate that the DNPH of pyruvaldehyde was used as a reference compound).

Separation of aldehyde DNPHs from heated citric acid-fructose solution. Preliminary separation of the DNPHs from the citric acid-fructose solution heated 300 minutes yielded 68 bands. Only one compound was isolated in the crystalline state in sufficient amounts for melting point determinations. These crystals were red, melted at 197-198° C., and were found to be the DNPH of HMF, as corroborated by its spectrum and mixed chromatogram with a known sample of the HMF derivative. Two other compounds were obtained in the crystalline state, but in such small quantity that melting point determinations could not be made. Both of these compounds were red in the crystalline state and were developed with benzene-petroleum ether (2:1). Their spectra indicated that they are unsaturated; one being an enal or dienal, and the other a dienal.

Separation of aldehyde DNPHs from volatile fraction of heated gel. For this work, with both gel and citric acid-fructose solution, alumina columns were used exclusively, and were always pretreated with the solvent in which the DNPHs's were dissolved.

The most soluble derivatives from the volatile fraction of the heated gel were dissolved by washing the derivatives with Skellysolve B until the washings were nearly colorless. The colored solution was then applied to the column and 6 bands formed without the aid of stronger solvents. Only band II was present in significant quantity. It was mechanically separated and eluted with ethyl acetate. Yellow crystals formed an evaporation of the solvent. The remaining derivatives yielded 7 bands, from which 2 crystalline compounds were obtained. Band III was developed with Skellysolve B-benzene (3:1). The bands were mechanically separated and eluted with ethyl acetate. Evaporation of the solvent left red crystals from band III and yellow crystal from band IV. Insolubility of these compounds in 5% sodium hydroxide indicated that they were not derived from volatile acids. On spraying spots of the derivatives with 10% sodium hydroxide, bands II and IV turned red. Band III became pink in color. Silberstein *(16)* has shown that ketone derivatives turn a grayish-brown color in alkali, whereas aldehyde derivatives turn red, red-brown, or blue. Therefore it was established that these crystalline compounds were derived from aldehydes.

Yellow crystals from band IV were present in larger amounts than those from bands II and III. Melting point of these crystals was 202-205° C. After recrystallization from redistilled ethanol, the melting point was raised to 209-210° C. This corresponds well with the melting point of 210° C. for trimethylacetaldehyde, as given Roduta and Quibilan *(13)*. The color of the latter is also yellow, and its low boiling point of 74-75° C. admits of the possibility of its presence. Location of its absorption maximum at 375, however, suggests that this compound is an enal. Since trimethylacetaldehyde was not available for comparative purposes, identity of this compound is left in doubt.

Yellow crystals from band II melted at 122.5-123.5° C. This value was not changed by recrystallization. This agrees with the value of 122° C. given by Shriner and Fuson *(15)* and 121° C. given by Matthiessen and Hagedorn *(10)*, for the DNPH of n-butyraldehyde. Comparison of two spectra, shown in Figure 2, and a mixed chromatogram on paper, using the solvent of Silberstein *(16)*, proved that it was n-butyraldehyde. The R_a (acetaldehyde) of the two compounds was 1.78.

Red crystals from band III had a melting point of 228-229° C. There was insufficient material for recrystallization. Melting point of the DNPH of furfural is variously given as 223° C. by Braude and Jones *(1)*, 229° C. by Shriner and Fuson *(15)*, 216-218° C.

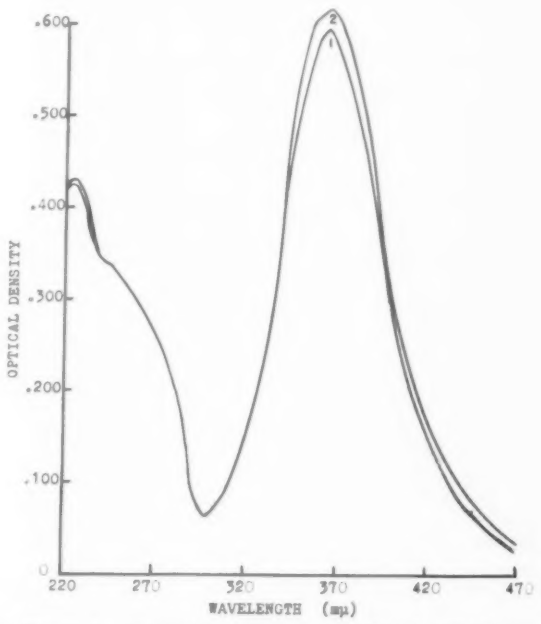

Figure 2. Absorption spectrum of dinitrophenylhydrazone of n-butyraldehyde:
1. **DNPH of pure n-butyraldehyde**
2. **DNPH of n-butyraldehyde from volatile fraction of gel**

by Silberstein *(16)*, and 230° C. by Brederick *(2)*. Comparison of spectra of the DNPH of the unknown compound in chloroform, Figure 3, together with that of the DNPH of a freshly distilled sample of furfural, indicated that it was furfural. This was confirmed by a mixed chromatogram on paper using the formic acid solvent previously described. The R_p was 1.49. The pink color in alkali of both the unknown and the furfural is additional evidence that the compounds are identical.

Chromatographic separation of DNPHs from volatile fraction of heated citric acid-fructose solution. DNPHs from the volatile fraction of the citric acid-fructose solution were washed with Skellysolve B, as were derivatives from the gel. The resultant pale yellow solution was applied to the column, and development with Skellysolve B-benzene (10:1) produced 4 weak bands, none of which was present in sufficient

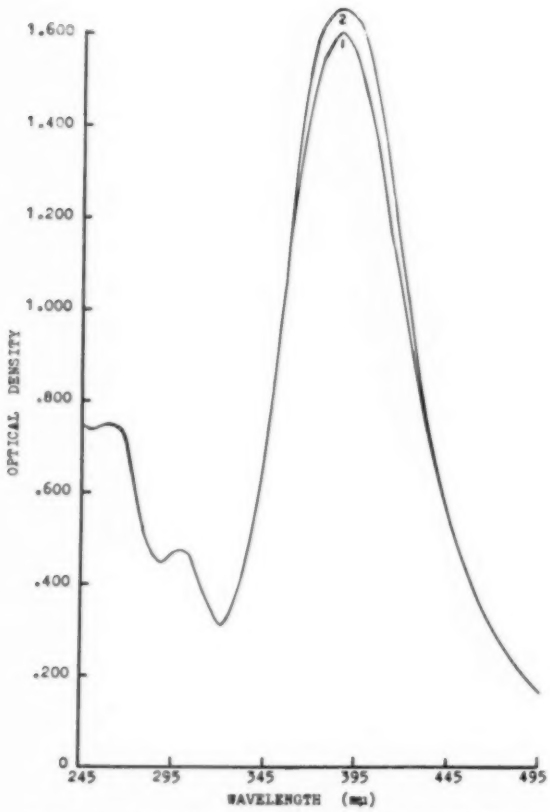

Figure 3. Absorption spectrum of dinitrophenylhydrazone of furfural:
1. DNPH of furfural from volatile fraction of gel
2. DNPH of pure furfural

quantity for study. Development with Skellysolve B-benzene (5:1) resulted in the formation of 5 bands. Band III, which was brown on the column, was removed after extrusion and eluted with ethyl acetate. Red crystals formed on evaporation of the solvent.

Use of Skellysolve B-benzene (4:1) as the next solvent resulted in the formation of 4 bands. Band I, which was yellow in color, and the most significant of the bands, was eluted by liquid chromatogram. Solvent evaporation left yellow crystals.

Remaining derivatives were dissolved in Skellysolve B-benzene (2:1). Development with Skellysolve B-benzene (1:1) resulted in the formation of 3 bands. Band III, the largest, was brown in color. It was mechanically separated and eluted with ethyl acetate. Red crystals mixed with yellow crystals formed during evaporation of the solvent.

Testing the crystalline derivatives with alkali indicated that they were all aldehydes. Spots of bands I and II on paper turned red, and band III turned pink on spraying with 10% sodium hydroxide. None of the crystals were soluble in 5% sodium hydroxide.

Yellow crystals from band I were present in larger amounts than those from bands II and II. Melting point of these crystals was 203-205° C. On recrystallization from ethanol the melting point increased to 209-210° C., where it remained constant. Comparison of the absorption spectrum of crystals of the same melting point from the gel showed that it was the same compound.

Red crystals from band II had a melting point of 234-235° C. Both the color of the crystals and their spectrum indicated unsaturation to the extent of possibly two double bonds.

Red crystals from band III had a melting point of 228-229° C. The absorption spectrum and mixed chromatogram on paper confirmed its identity as furfural.

Effect of added aldehydes on the rate of discoloration of standard gel. To determine the roles of HMF, furfural, and n-butyraldehyde, in the formation of discoloration in gels, they were added individually, and as a mixture of all three to establish the significance of their combined effects. The free aldehydes were added in concentration of 0.6 and 1.2%, by weight, of the theoretical amount of fructose present in the unheated gel. Although visual comparison of the amounts of DNPHs identified indicated that HMF was formed in the greatest amount, and that there was more butyraldehyde formed than furfural, all compounds were added in the same concentrations to permit a comparison of their individual effects on an equal weight basis.

Samples were heated in sealed tubes in an oil bath at 230° F. (110° C.) for 0, 60, 90, and 120 minutes. After 30 minutes of heating all tubes were shaken to mix the contents. Optical density measurements were made at 450 mμ using a Coleman Junior spectrophotometer. Measurements were made in the tubes in which the gels were heated. Results, shown in Figures 4 and 5, indicate that all the aldehydes caused increased darkening over the control. Discoloration increased in the order HMF, furfural, n-butyraldehyde. Combined aldehydes, at the lower concentration, showed increased darkening over the control, approximately equal to the summation of the effects of the individual aldehydes. Increasing the concentration of the aldehydes increased rate of browning.

Effect of added aldehydes on the rate of discoloration of citric acid-fructose solutions. Citric acid-fructose solutions were made up in concentrations such that the fructose was equal to that theoretically present in a gel. All tubes were treated in the same manner as the gels.

Although n-butyraldehyde was not isolated from the citric acid-fructose solution, it was added to determine what its effect might be. Additional tubes were prepared containing only HMF and furfural as the added aldehydes. The data, shown in Figures 6 and 7, tend to show that n-butyraldehyde plays no role in the browning of these solutions. When added separately to citric acid-fructose solutions, there was no significant difference in browning between these solutions and those containing only HMF and furfural.

SUMMARY AND CONCLUSIONS

The role of carbonyl compounds in the darkening of preserves and jellies was studied in "model" systems

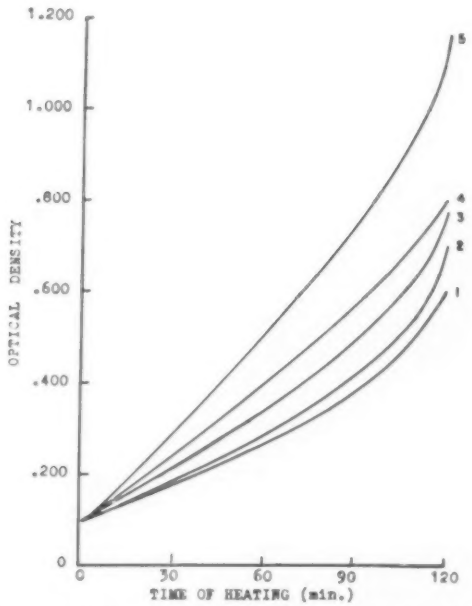

Figure 4. Effect of added aldehydes on the rate of browning of standard gel (aldehydes added at 0.6% level):
1. control
2. n-butyraldehyde
3. furfural
4. HMF
5. HMF, furfural and n-butyraldehyde

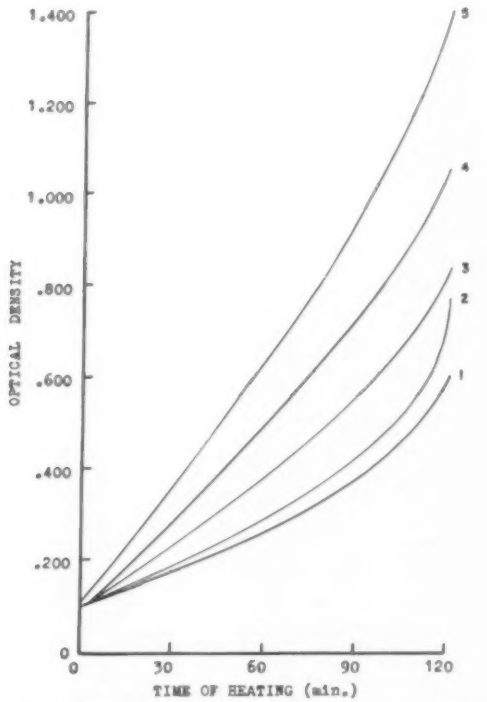

Figure 5. Effect of added aldehydes on the rate of browning of standard gel (aldehydes added at 1.2% level):
1. control
2. n-butyraldehyde
3. furfural
4. HMF
5. HMF, furfural and n-butyraldehyde

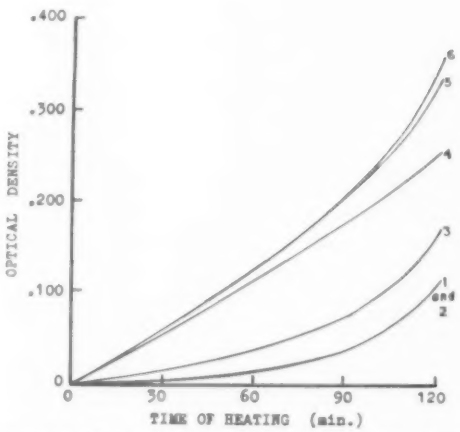

Figure 6. Effect of added aldehydes on the rate of browning of citric acid-fructose solutions (aldehydes added at 0.6% level):
1. control
2. n-butyraldehyde
3. furfural
4. HMF
5. HMF and furfural
6. HMF, furfural and n-butyraldehyde

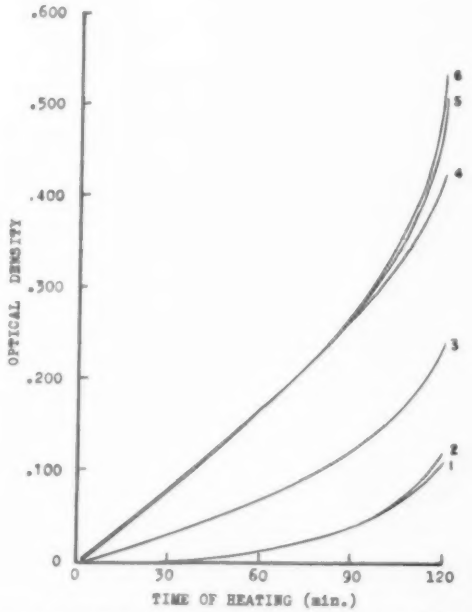

Figure 7. Effect of aldehydes on the rate of browning of citric acid-fructose solutions (aldehydes added at 1.2% level):
1. control
2. n-butyraldehyde
3. furfural
4. HMF
5. HMF and furfural
6. HMF, furfural and n-butyraldehyde

composed of citric acid-sucrose-pectin gels, citric acid-glucose, citric acid-fructose, and citric acid-galacturonic acid solutions.

Fourteen crystalline aldehyde (DNPHs) were isolated from a gel heated 300 minutes at 110° C. Their ultraviolet spectra indicated that five were saturated compounds; the remainder were unsaturated, three being enals or dienals, four dienals, and two di- or trienals. One of the dienals was identified as HMF. Three crystalline compounds were isolated from a citric acid-fructose solution heated 300 minutes at 110° C. One of these was identified as HMF, the other compounds were enals or dienals. Furfural and n-butyraldehyde were isolated as DNPHs from the volatile fraction of a gel. Furfural was isolated from the volatile fraction of a citric acid-fructose solution. The largest component of the volatile aldehydes formed a yellow crystalline DNPH which melted at 209-210° C. Its identity was not established.

When added back to their "parent" systems, and heated, n-butyraldehyde, furfural, and HMF produced darkening above that produced in the controls, confirming that they are responsible, at least in part, for browning in these systems.

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The Resistance of Bacterial Spores to Superheated Steam[a]

(Manuscript received June 13, 1956)

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FOR THE PAST FEW YEARS the Aseptic Canning System, designed by W. McK. Martin *(4)* and manufactured by the James Dole Engineering Company, has been used commercially in a number of canneries. In this system the containers and covers are sterilized by superheated steam. Because no data were available on the resistance of bacterial spores to superheated steam, a study was undertaken to determine the rates of destruction and slopes of thermal death time curves ("D" and "z" values) for the sporeforming bacteria Putrefactive Anaerobe (PA) 3679, (a mesophilic anaerobe), and Flat Sour (FS) 1518 *(Bacillus stearothermophilus)*, a thermophilic facultative anaerobe. These are standard test organisms in the canning industry for use in the establishment of processes for canned foods. In addition, tests were made with a sporeforming facultative anaerobe identified as *Bacillus polymyxa* (coded as PSO), isolated from a spoilage case involving the aseptic canning system.

EXPERIMENTAL METHODS

Preparation of spore suspensions. Spore suspensions of the facultative anaerobes were prepared by inoculating actively growing cultures on nutrient agar in Kolle flasks. After incubation for 2 days at 50° C. for FS 1518, or 4 days at 37° C. for *B. polymyxa*, they were held for 2 days at room temperature. The spore crops on the agar were then washed off with sterile tap water, filtered through non-absorbent cotton layered between cheese cloth and water washed 3 times by means of a centrifugation procedure. This involved discarding the supernatant after each centrifuging and re-suspending the spores in sterile water. After the supernatant liquid from the third centrifuging was discarded, the spores were re-suspended in sterile tap water in flasks and stored at 5° C. until used. Glass beads were added and the flasks were shaken 20 minutes to break up spore clumps. The number of spores in these stock suspensions was determined by plating, in duplicate, serial dilutions in dextrose tryptone agar.

The spore suspension of PA 3679 was prepared by allowing the organism to grow for 2 weeks in liver broth, filtering through cheese cloth and non-absorbent cotton, concentrating and washing the resulting spore crop by centrifuging and discarding the supernatant. The suspension was water washed 3 times by the above centrifugation procedure and finally was re-suspended in sterile water. Spore clumps were broken up by shaking for 20 minutes the flask containing the suspension to which glass beads had been added. Counts were made by culturing the dilutions of the suspensions in Yesair's pork infusion agar (modified[c]) in Prickett tubes. The tubes were layered with sterile vaseline after inoculation to maintain anaerobic conditions.

Inoculation and heating procedures. One-tenth ml. amounts of appropriate dilutions of the suspension were placed at the center of 202 diameter lids[d] and dried. The lids were then subjected to superheated steam in the cover sterilizer of an Aseptic Canning unit. For most of the tests the aseptic system was run at a speed of 60 cans per minute, resulting in an exposure time of the covers to steam of 77 seconds. The temperatures of the covers during the heating period were determined[e] and were found to approach the sterilizer temperature at a logarithmic rate. The 202 x 214 cans each containing approximately 29 g. of sterilized sand were passed through the can sterilizer, filled with 30 to 50 ml. of sterile water and sealed aseptically with the inoculated heat-treated covers. To minimize possible contamination, cans containing spores of PA 3679 were then heated at 212° F. for 5 minutes; those containing FS 1518 spores, 10 minutes at 212° F.; cans with PSO spores, 10 minutes at 180° F. The cans were subsequently shaken at an angle of 45°, inoculated end down, for 20 minutes, which resulted in almost 100% dispersion of the spores in the water.

Spore recovery procedures. To determine the number of viable spores in the water, the cans were opened aseptically, and aliquots were withdrawn and cultured in appropriate media. For FS 1518 the aliquots were plated in dextrose tryptone agar and incubated 4 days at 50° C. Two-day and 4-day colony counts were made and the higher count accepted as the basis for estimating the number of surviving spores. Dextrose tryptone agar plates were also used to enumerate the viable spores of *B. polymyxa*. The plates were counted after 4 and 7 days at 37° C. Again, the higher reading was accepted as representing the number of viable spores. For PA 3679, Prickett tubes containing pork infusion agar (Yesair's modified) stratified with sterile vaseline after inoculation, were used to enumerate the surviving spores. The colonies were counted at the end of one, two and three weeks incubation at 30° C.

In all tests duplicate plates or tubes were used for each aliquot or dilution. The exact amount of water in each can was determined by obtaining the difference in weight before and after removing the water. Data typical of test results are presented in Table 1.

TABLE 1

Survival of spores of FS 1518 exposed to superheated steam

Code	Cover duct temperature ° F.	Total spore survival per lid (Average of 4 samples, 2 plates each)		
		Dilution 1[f]	Dilution 2[f]	Dilution 3[f]
Rm	140	727,500	55,400	3,240
L	259	980,000	50,475	3,428
K	299	767,170	48,400	3,143
J	331	235,300	27,350	1,887
H	340	51,000	12,188	914
G	350	1,086	1,257	107.6
F	360	1.14	6.0	0

[f] Dilution 1—0.1 ml. whole suspension per lid.
Dilution 2—0.1 ml. of a 1:10 dilution per lid.
Dilution 3—0.1 ml. of a 1:100 dilution per lid.

METHODS FOR ANALYSIS OF DATA

Because of the fact that the inoculated covers were not heated instantaneously to the sterilizer temperature, the problem arose of determining the amount of lethal heat received by the spores. This could only be calcu-

[a] Presented at the 16th Annual Meeting of IFT, June 11, 1956, St. Louis, Missouri.

[b] Now with Andersen's Foods, Inc., Santa Barbara, California.

[c] To prepare modified Yesair's medium add one liter distilled water to one pound ground lean pork and boil one hour. Remove meat and fat, make up to volume and add 5 g. peptone, 1.5 g. tryptone, 1.25 g. K_2HPO_4, 1 g. glucose, 1 g. soluble starch and 15 g. agar. Adjust to pH 7.5. Final boiling results in a precipitate which should be allowed to settle and then removed.

[d] In the canning industry can dimensions (over-all diameter and over-all height) are identified by three digit numbers. The left-hand digit gives the number of whole inches, while the two right-hand digits represent sixteenths of an inch.

[e] Data supplied by the James Dole Engineering Company.

lated when the slope of the thermal death time curve was known. It was necessary, therefore, to determine z from the available data.

For any series of thermal death time tests involving samples which are the same with respect to heating characteristics, a relationship can be established between the process temperature, the number of surviving bacteria and the rate of change, with temperature, of the death rate of the bacteria *(5)*; provided that only one bacterial species is used and that the bacteria (or spores) have a constant rate of change, with temperature, of the death rate for the temperatures used in the tests, that the process times are constant, and that all portions of the materials heat at a constant rate.

For example, let us assume that a series of processes were given cans of food each containing the same material inoculated with the same amount of a bacterial spore suspension. In symbols familiar in process calculations in the canning industry *(4, 5)*, constants would be: process time (B_B); heating characteristics of the can and product (f_h, j); initial temperature (I.T.). Process temperature would be variable. In the range of process temperatures lethal to some but not all of the spores, the number of surviving spores would decrease as the process temperature increased. A plot of the logarithm of spore survival against the lethal rate ($1/F_i$) would result in a straight line. However, the lethal rate is dependent on a resistance characteristic of the organism, i.e., the slope of the thermal death time curve (z) or the change in degrees Fahrenheit for a tenfold change in the death rate. This relationship is as folllows:

$$F_i = \log^{-1} \frac{\text{Reference Temperature} - \text{Process Temperature}}{z}$$

If the z value is not known, by plotting the logarithm of the number of surviving spores against $1/F_i$ (see Table 2) for various z values it can be seen that one, and only one, z will result in a straight line.

Applying this method to the data in Table 1, resistance characteristics of spores of FS 1518 to superheated steam were calculated. The reference temperature used was 350° F. In calculating the z values the zero heating time count was selected as the maximum count for each spore concentration tested.

The following z values were obtained by the method outlined, which is demonstrated graphically for one suspension in Figure 1:

Dilution	z Value
0.1 ml. of undiluted suspension	30
0.1 ml. of 1:10 dilution	25
0.1 ml. of 1:100 dilution	25

The second phase of the analysis of data is the determination of the rate of destruction value (D). Since the reference temperature has been established as 350° F., this will be D_{350}. The heating curves of 202 diameter lids in the aseptic cover sterilizer duct are characterized by $f_h = 41.2$ seconds and $j = 2.58$.

The calculation of F_{350} for the experimental conditions follows (F = lethal time at reference temperature):

$$\frac{B_B}{f_h} = \log jI - \log g$$

(g = the difference between the process temperature and the temperature of the material being heated at the end of the heating cycle.)

1. For Duct Temperature = 360° F.:

$$\frac{77}{41.2} = \log (2.58 \times 155) - \log g. \qquad g = 5.36$$

2. For Duct Temperature = 350° F.:

$$\frac{77}{41.2} = \log (2.58 \times 145) - \log g. \qquad g = 5.05$$

3. For Duct Temperature = 340° F.:

$$\frac{77}{41.2} = \log (2.58 \times 135) - \log g. \qquad g = 4.7$$

4. For Duct Temperature = 331° F.:

$$\frac{77}{41.2} = \log (2.58 \times 130) - \log g. \qquad g = 4.39$$

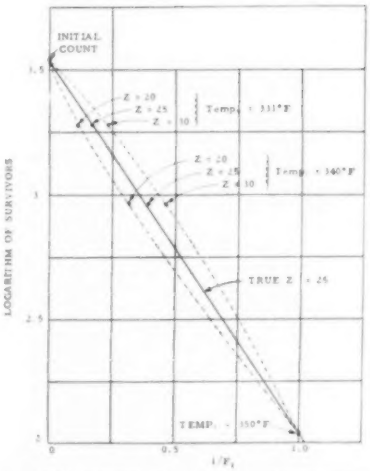

Figure 1. Establishment of Z for B. stearothermophilus in superheated steam. (Suspension diluted 1:100.)

Duct Temp. °F.	g	For z = 30				For z = 25			
		$\frac{f_h}{U^*}$	U^*	F_i	F_{350} (sec.)	$\frac{f_h}{U^*}$	U^*	F_i	F_{350} (sec.)
360	5.36	3.0	13.7	0.46	29.6	3.25	12.7	0.4	31.8
350	5.05	2.8	14.7	1.0	14.7	3.10	13.3	1.0	13.3
340	4.7	2.6	15.8	2.17	7.36	2.90	14.2	2.5	5.68
331	4.39	2.5	16.5	4.3	3.85	2.75	15.0	5.75	2.61

* U = lethal time at process temperature ($U = FF_i$).

To construct the death rate curves the logarithms of the number of surviving spores were plotted on coordinate paper against the corresponding times in seconds (F_{350}) as shown in Figure 2. From these curves the following values were obtained: for Dilution 1, $D_{350} = 5.0$ seconds; for Dilution 2, $D_{350} = 8.0$; and for Dilution 3, $D_{350} = 8.5$.

TABLE 2

Duct Temp. °F.	F_i and $\frac{1}{F_i}$ Values for Various z Values (Reference Temperature—350° F.)									
	z = 20		z = 23		z = 25		z = 27		z = 30	
	F_i	$\frac{1}{F_i}$	F_i	$\frac{1}{F_i}$	F_i	$\frac{1}{F_i}$	F_i	$\frac{1}{F_i}$	F_i	$\frac{1}{F_i}$
299	355	.0027	166	.006	110	.0091	77.6	.0128	50	.02
331	8.9	.112	6.71	.149	5.75	.174	5.06	.198	4.3	.233
340	3.16	.316	2.72	.368	2.52	.397	2.35	.425	2.17	.46
350	1	1	1	1	1	1	1	1	1	1
360	.316	3.16	.377	2.65	.4	2.5	.426	2.34	.463	2.16

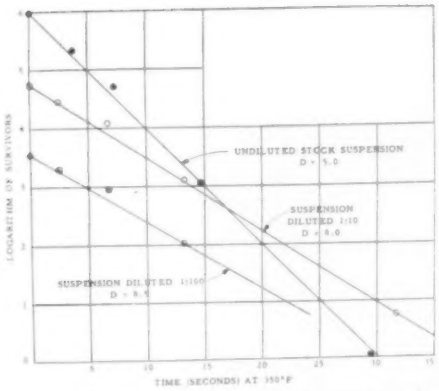

Figure 2. Death rate curve. FS 1518 in superheated steam.

From the z and D_{350} values thermal death time curves were constructed (Figure 3).

The values are in close agreement for the stock suspension diluted 1:10 and 1:100 with water. On the other hand, there is a clear indication that some material in the undiluted suspension strongly influenced the resistance of the test organism to superheated steam. In view of this, the remainder of the tests were made using at least a 1:10 dilution of the stock spore suspension.

The following data (Tables 3, 4, 5, 6) were obtained in tests subsequent to those already reported and involved not only FS 1518 (Table 3) but also PSO (Tables 4, 5) and PA 3679 (Table 5). In calculating the resistance values z and D, where Ball's formula method could not be applied the general method of Bigelow *et al. (2)* was utilized.

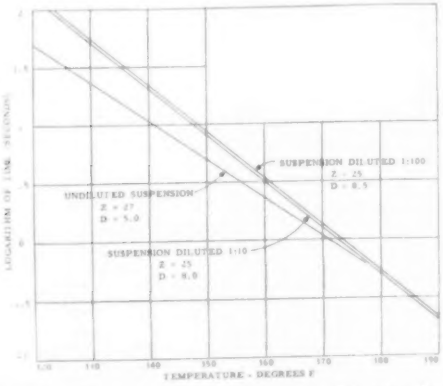

Figure 3. Thermal death time curves. FS 1518 in superheated steam.

Once the z of each organism was established, both times and temperatures were varied in subsequent tests to obtain further corroborative evidence of the resistance characteristics.

A comparison was made between the resistance of the test spores to superheated steam and their resistance to moist heat. Moist heat resistance was determined by the thermal death time tube method of Bigelow and Esty *(3)*, with the spores heated in neutral (M/15) phosphate buffer. The resistances are compared in Table 7 and Figure 4.

TABLE 3
Results of tests on FS 1518

Process		Logarithm of Survivors	Most Applicable z	F_{250} (seconds)	Most Applicable D_{250} (seconds)
Time (seconds)	Temp. (° F.)				
Test 2. Dilution of whole culture 1:10					
77	357	less than 0.86	26	21.94	5.6
77	351	1.46		14.42	
77	343.5	2.79		7.80	
77	340	2.95		6.20	
77	331.5	3.66		2.9	
77	140-200	3.96			
Test 3. Dilution of whole culture 1:10					
77	348	3.27	26	10.92	7.8
77	336	4.165		4.04	
84	340	3.93		7.82	
93.7	340	3.48		11.32	
100.3	340	3.30		13.53	
77	328	4.40		2.13	
94.5	334	4.15		6.87	
112.6	330	4.09		7.82	
131.6	330	3.75		10.32	
115.5	322	4.25		4.10	
154	320	4.21		6.16	
197.5	320	4.075		9.17	
77	140-200	4.235			

The results indicate that the spores of the three species are far more resistant to superheated steam than to moist heat. It is interesting to note the great difference in z values between the *Clostridium* species PA 3679, and the two Bacillus species, *B. polymyxa* and *B. stearothermophilus*. The effect of this difference is strikingly demonstrated in the F values at 250° F. and 350° F. in superheated steam. It should also be noted that while *B. polymyxa* has little resistance to moist heat, its resistance is nearly as great as that of *B. stearothermophilus* in superheated steam. In more recent experiments, not reported here, in which spores of these two species were exposed to hot gases of very

TABLE 4

Results of tests on B. polymyxa (PSO)

Process		Logarithm of Survivors	Most Applicable z	F_{250} (seconds)	Most Applicable D_{250} (seconds)
Time (seconds)	Temp. (° F.)				
Test 1. Dilution of whole culture 1:10					
77	360	0.316	22	28.39	6.0
77	350	3.276		11.0	
77	338	4.365		3.83	
77	330	4.582		1.57	
77	300	4.747		0.05	
77	140-200	5.132			
Test 2. Dilution of whole culture 1:100					
77	360	0.306	30	29.21	8.0
77	350	2.148		14.94	
77	338	2.924		6.90	
77	330	3.512		3.72	
77	300	3.618		<0.2	
77	140-200	4.016			
Test 3. Dilution of whole culture 1:10					
77	360	0.4	30	29.21	6.8
77	348	3.02		12.9	
77	336	4.08		5.65	
77	325	4.43		2.7	
77	294	4.52		<0.2	
77	140-200	4.86			
Test 4. Dilution of whole culture 1:100					
77	360	<0	30	29.21	7.5
77	348	2.2		12.9	
77	336	3.23		5.65	
77	325	3.477		2.7	
77	294	3.654		<0.2	
77	140-200	3.91			
Test 5. Dilution of whole culture 1:10					
77	355	2.18	26	19.93	6.4
84	355	0.95		27.63	
77	350	3.07		13.23	
83.5	350	2.23		18.27	
78.5	340	4.11		6.20	
84	340	3.74		7.91	
98	340	3.59		12.86	
106	340	3.30		15.87	
78	330	4.59		2.67	
94	330	4.43		4.99	
115	330	4.34		8.10	
130	330	4.12		10.65	
115	319	4.69		3.19	
160	324	4.04		9.27	
200	318	4.40		7.90	
77	140-200	5.01			

low water content, the *B. polymyxa* spores were far more resistant than those of FS 1518, although the resistance of both was greatly increased. Aside from any possible toxic effect of the gas itself, therefore, superheated steam is a more efficient sterilizing medium than a drier gas, such as flue gas, and is more suitable for use in aseptic canning equipment operated at atmospheric pressure.

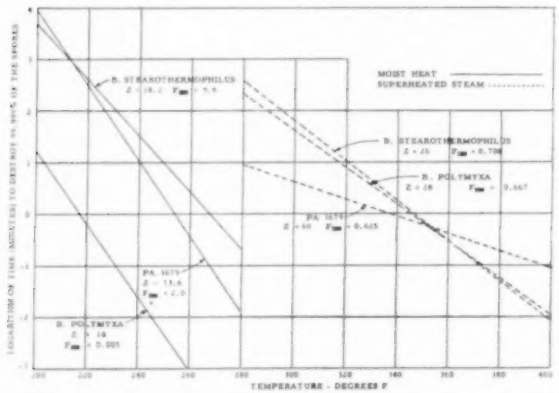

Figure 4. Comparison of spore resistance in moist heat and superheated steam.

TABLE 5

Results of tests on PA 3679

Process		Logarithm of Survivors	Most Applicable z	F_{250} (seconds)	Most Applicable D_{250} (seconds)
Time (seconds)	Temp. (° F.)				
Test 1. Dilution of whole culture 1:10					
77	350	0.74	60	22.8	5.0
77	338	1.93		15.07	
77	330	3.3		11.51	
77	320	4.02		7.8	
77	300	5.404		.....	
77	140-200	4.492		.....	
Test 2. Dilution of whole culture 1:100					
77	350	0.6	60	22.8	6.15
77	338	1.98		15.07	
77	330	2.75		11.51	
77	320	3.14		7.8	
77	300	4.78		.....	
77	140-200	3.78		.....	
Test 3. Dilution of whole culture 1:10					
77	345	0.68	60	20.0	4.5
78.5	340	1.68		18.0	
77	330	2.69		12.1	
78	320	3.65		8.78	
77	140-200	5.15		.....	
Test 4. Dilution of whole culture 1:100					
77	345	0.96	60	20.0	7.7
83	346	0.41		25.55	
78.5	340	1.99		18.0	
84	340	1.72		21.05	
77	330	2.518		12.1	
85	329	2.39		14.95	
94	330	2.25		19.4	
78	320	3.0		8.78	
94	320	2.75		13.47	
115	319	2.625		19.56	
77	140-200	4.33			

TABLE 6

Summary of resistances

Organism	Dilution of Whole Culture	Resistance Characteristics	
		z	D_{250} (seconds)
FS 1518	none	27	5.2
	1:10	25	8.0
	1:10	26	7.8
	1:10	26	5.6
	1:100	25	8.5
B. polymyxa (PSO)	1:10	30	6.8
	1:10	22	6.0
	1:10	26	6.4
	1:100	30	7.5
	1:100	30	8.0
PA 3679	1:10	60	5.0
	1:10	60	4.5
	1:100	60	6.15
	1:100	60	7.7

NOTE: Highest resistances were obtained with the more dilute suspensions.

TABLE 7

Comparison of resistance—moist steam and superheated steam

Organism	Resistance to moist steam		Resistance to Superheated Steam		
	z	F_{250}	z	F_{250}	F_{250}
B. polymyxa	14.0	0.005	28	3160	0.667
FS 1518	18.2	9.6	26	4680	0.708
PA 3679	13.6	2.0	60	32	0.625

Notes: (1) All spore suspensions water washed three times.
(2) F_{250} and F_{250} values in minutes and based on reduction of 100,000 spores to 1 spore.

It may be concluded that the greater the degree of saturation of a hot gas with condensable water vapor, the more lethal is the gas to dry bacterial spores.

SUMMARY

The resistance characteristics of spores of three bacterial species to superheated steam have been determined. These characteristics are as follows:

Organism	Type	Resistance	
		z	F_{250} (minutes)
B. stearothermophilus (FS 1518)	Thermophilic flat sour	26	0.708
B. polymyxa (PSO)	Mesophilic gas-producing facultative anaerobe	28	0.667
PA 3679	Putrefactive anaerobe	60	0.625

It was found that the more dilute the suspension the greater the apparent resistance of the bacterial spores to this type of heat.

No correlation was observed between resistance to superheated steam and resistance to saturated steam.

Based on these tests, sterilization of surfaces by superheated steam can be accomplished by heating the surfaces to a temperature of above 350° F. for one minute, or to a temperature above 320° F. for 10 minutes.

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Consumer Survey on the Dessert Quality of Canned Apricots[a]

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Few tasks could be more challenging to a food technologist than that of analyzing the food preferences of the consuming public. Most food acceptance laboratories have modern facilities for determination of differences and preferences for food products as expressed by trained taste tasters. However, the expert taster's predictions of consumer opinion can be erroneous if they are not frequently audited by a statistical check with consumer sampling *(13)*. Although all consumers are not equally discriminating, and some may do no more than venture a guess, actual tests indicate that we may not give the public enough credit for taste intelligence, especially when they disagree with us *(1, 10)*. Many negative factors which are a part of mass taste testing must be offset by careful attention to numerous details, some of which will be mentioned here.

Not only is it important to use a large enough sample to obtain significant statistical results, but also conclusions should be reported only in terms of the particular group interviewed *(1, 6, 7, 12)*. Naturally, the attitude and interest of the participants are great aids in consumer research *(26)*.

Validity of questionnaires employed in consumer testing increases if carefully prepared and pretested, with supplementary questions designed to reveal the accuracy of the main replies. Coding of samples can influence responses as reported by Garnatz *(15)*, Ishler *et al. (20)* and Krum *(21)*.

Despite the introduction of many uncontrollable variables, it is best to operate in the home under normal conditions of consumption to avoid tests which force an immediate and hasty decision *(1, 13, 29)*. Also, direct interviewing is generally preferable to the mailing technique *(26)*. Whether the consumer should compare two products or judge only one, is largely a matter of opinion *(1, 6, 12, 19, 30, 32)*. With a single product test, the evaluation is a memory comparison based on previous experience with similar products *(19)*. Many workers agree that both simultaneous and successive presentation are vulnerable to the influence of order of presentation *(5, 16, 25, 26, 29, 30, 32, 33)*.

Although people's attitudes, habits, opinions and knowledge influence food acceptance, flavor is the most important single factor in determining the level of preference *(28)*. For years, canners have added sugar syrups to canned fruits to improve and conserve flavor as well as to retain color, appearance and most of the original texture of the fruit *(8, 31)*. Laboratory panels and consumer surveys have suggested that sucrose, up to specified levels, enhances the flavors of aqueous solutions containing synthetic flavoring *(35)*, fruit nectars *(36)*, cling peaches *(33)* and freestone peaches *(37)*. The present paper considers the consumer acceptance of apricots canned at five sweetness levels and classifies these opinions according to information collected from the sample interviewed regarding age, sex, body size, and time of day of tasting.

METHODS AND MATERIALS

Raw material. Blenheim apricots, obtained from two prominent California growing areas, Winters and Santa Clara County, were evaluated in this survey. These apricots were sorted for maturity and blemishes under a standard light source in the

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pilot plant of the Department of Food Technology. After pitting, 19.5 oz. of unpeeled apricot halves were weighed into 401 x 411 size cans and 253 ml. of sucrose syrup of either 30°, 40°, 50°, 60° or 70° Brix was added. Cans were vacuum closed and cooked in an atmospheric rotary cooker at 210° F. for 22 min. for fruit grown in the Winters area and 33 min. for fruit produced in Santa Clara County.

Canned fruit was stored at room temperature for 6 weeks to allow the apricots and sugar syrup to equilibrate, then chemical analyses were made (Table 1). Outstanding difference between

TABLE 1
Chemical analyses of canned Blenheim apricots

Winters[1]				
In-Going Brix	Cut-Out Brix	pH	Total Acid[2]	SS/A[3]
30°	19.50	3.86	0.755	25.84
40	23.08	3.85	0.740	31.22
50	28.57	3.88	0.737	39.34
60	30.22	3.89	0.715	42.32
70	33.09	3.86	0.732	45.28
Santa Clara[1]				
In-Going Brix	Cut-Out Brix	pH	Total Acid[2]	SS/A[3]
30°	19.62	3.68	0.633	31.04
40	23.08	3.71	0.603	38.41
50	27.10	3.72	0.623	43.94
60	30.60	3.70	0.579	52.86
70	35.24	3.69	0.593	59.53

[1] Average of 7 analyses.
[2] As percent citric acid.
[3] Soluble solids to acid ratio.

the apricots from the two growing areas was the greater total acidity of the Winters fruit. This, in turn, results in definite differences in the soluble solids-acid ratio (SS/A) between the 2 apricot samples.

Consumer sampling. A total of 200 families was selected at random from the telephone directory of Davis, California (pop. 6,000) and asked to participate in a household consumer survey. Of these families, 181 agreed to participate.[b] Individual responses were obtained for each of the 5 sweetness levels from 537 people over 6 years of age. A summary of the types of individuals responding is given in Table 2.

TABLE 2
Classification of participants according to sex and age

	Group A[1]		Group B[2]		Composite		
Age group	Male	Female	Male	Female	Male	Female	Totals
6-18	29	34	45	39	74	73	147
18-35	30	41	32	43	62	84	146
35-50	37	35	48	42	85	77	162
Over 50	23	26	15	18	38	44	82
Totals	119	136	140	142	259	278	537

[1] Families evaluating apricots grown in Winters.
[2] Families evaluating apricots grown in Santa Clara.

Experimental design. During January, 1956, one can of apricots from each of the 5 sweetness levels was delivered to each family taking part in the study. One-half of the families evaluated apricots grown in Winters, whereas the remaining half received samples of fruit grown in Santa Clara County. No household member was aware of the fact that the variation from can to can was sugar content. Approximately 18 to 20 days were allowed for the tasting of the 5 cans of fruit.

In a consumer acceptance test the system used and the instructions given must be kept simple. Since there is no opportunity to train a large number of people, ambiguity may easily develop (*9, 17*). Consequently, each homemaker received a printed instruction sheet explaining the nature of the survey and listing explicit directions for tasting. Every can was to be refrigerated to insure that the apricots would be served cold. Consumers were requested to taste each sample, separately, as a plain dessert after a regular family meal and to allow at least one major meal between tasting each sample. Cans were identical in appearance, unlabelled and distinguishable only by a two-digit number on the side and on the lid, assigned at random in no particular sequence so as not to influence the order of tasting. The homemaker was allowed to open the cans in any order she preferred.

Individual family members indicated their opinion of the dessert quality of every sample on personal score sheets with numbers corresponding to the can code. It was believed that with a hedonic scale, measuring degree of *like* and *dislike* in several steps, with additional questions as needed, reliable results could be obtained from consumers (*2, 13, 27, 28, 34*). Further, the hedonic scale rating has the advantage of representing the attitudes of a group of people toward a specific food under a given set of conditions. For this reason, a hedonic scale of 9 descriptive terms, ranging from *like extremely* to *dislike extremely* was employed. In order to determine the basis for the reaction, two questions were asked: "What did you like about these apricots?" and "What did you dislike about these apricots?" Sufficient space was provided for additional comments.

Valuable information may be derived by classifying preferences and supporting reasons according to age, sex, and other characteristics of testers (*11*). Therefore, participants were asked to record the time of day the fruit was tasted, as well as their age and sex. Since it was of interest to determine whether factors of overweight or underweight could be reflected in sweetness preferences, data on height and weight of adults were collected from the housewife by the interviewer when the completed score sheets were picked up.

One month after the survey had been completed, a letter was mailed to each household explaining briefly the main results of the study and informing the family as to its performance in relation to the group as a whole.

RESULTS AND DISCUSSION

Of the 181 families participating in the survey, 100% returned their score cards to the interviewer within the allotted time period. To facilitate analysis, numbers ranging from 1 to 9 were assigned to the 9 descriptive terms on the completed score sheets. The average scores, classified as to age and sex, are presented in Table 3. It can be seen readily, that all the apricots from both growing areas were fairly well-liked. (Values of 6 and 7 correspond to *like slightly* and *like moderately*, respectively, on the hedonic scale used.) A large number of consumers remarked that the experimental packs of apricots were superior in dessert quality to canned apricots available in the local markets.

For both growing areas, apricots canned at the 3 middle sweetness levels were preferred over the 2 extremes, indicating that the sweetness range was wide enough to bracket the preference of the particular sample interviewed. By comparing the average scores for grand totals in Table 3 with the chemical analyses of the canned fruit (Table 1), it is apparent that a relationship exists between acceptance and the ratio of soluble solids to acid. These data have been plotted in Figure 1. The most highly accepted apricots had a soluble solids-acid ratio of between 38 and 40. Because the apricots grown in the Winters area possessed a higher total acidity, the consumer preferred them

[b] Approximately 5% of these families had participated in previous surveys (*14, 34*), but the remaining families, to our knowledge, had not been exposed to consumer sampling previous to this investigation.

TABLE 3
Effect of age and sex on responses for sweetness of canned apricots
Average scores

Winters Age Groups	In-Going Brix					F.	L.S.D.*
	30°	40°	50°	60°	70°		
Males							
Under 18	6.54±1.60	6.96±1.44	7.07±1.60	6.56±2.42	7.00±1.82	0.56	
18-35	6.27±1.47	6.47±1.53	6.40±1.49	6.63±1.53	6.43±2.12	0.15	
35-50	6.11±1.71	6.69±1.82	7.03±1.79	7.34±1.44	6.86±1.93	0.48	
Over 50	6.46±1.96	6.68±1.55	7.48±0.90	7.34±1.55	7.07±1.54	1.78	
Total	6.31	6.70	6.96	6.97	6.82	2.75*	0.32
Females							
Under 18	6.70±1.78	6.76±1.80	7.50±1.29	7.21±1.67	6.79±2.07	1.26	
18-35	6.39±1.88	6.93±1.59	7.32±1.28	6.59±1.92	6.20±1.96	2.66	
35-50	6.44±1.72	7.00±1.81	6.90±2.00	6.89±2.36	6.40±2.10	0.71	
Over 50	6.70±1.93	7.00±1.56	7.30±1.69	7.28±1.66	7.36±1.60	0.59	
Total	6.33	6.77	7.26	6.95	6.61	3.34**	0.04
Grand Total	6.43	6.73	7.12	6.99	6.71	5.24***	0.22
Santa Clara Age Groups							
Males							
Under 18	6.68±1.70	7.00±1.56	6.73±1.74	7.23±1.74	6.11±2.01	2.58*	0.51
18-35	6.34±1.67	7.06±1.79	6.83±1.41	7.40±1.13	6.59±1.60	4.30**	0.56
35-50	6.60±1.47	6.80±1.81	6.80±1.36	7.07±1.52	5.92±1.86	3.38**	0.47
Over 50	6.36±1.84	7.36±1.50	7.21±1.57	7.11±1.08	6.20±2.45	1.32	
Total	6.55	6.99	6.83	7.09	6.15	7.96***	0.33
Females							
Under 18	6.84±1.84	7.05±1.47	7.05±1.81	7.03±1.77	6.79±1.64	0.21	
18-35	6.39±1.90	7.49±1.50	7.05±1.80	6.57±1.89	5.74±2.13	5.31***	0.56
35-50	6.70±2.04	7.29±1.26	7.10±1.70	7.15±1.04	5.98±1.95	4.00**	0.53
Over 50	6.11±2.02	7.50±1.26	7.31±1.80	7.41±1.41	6.70±2.26	1.85	
Total	6.58	7.31	7.10	6.89	6.29	8.47***	0.11
Grand Total	6.56	7.14	6.96	6.99	6.22	15.52***	0.25

*Sig. at P = 0.05.
**Sig. at P = 0.01.
***Sig. at P = 0.001.

sweeter. This relationship between sweetness and acidity has been demonstrated in both raw and processed fruits by other workers in this laboratory *(24, 33, 36)*.

Effect of age. The analysis of variance of the average scores showed that there was a significant effect on sweetness preference attributable to age group for participants testing apricots from Winters only. The overall means for apricots from this area for the 4 age groups, in chronological order, were 6.91, 6.56, 6.77 and 7.06, respectively. This indicates that individuals under 18 and over 50 scored the apricots higher than did people in the middle age groups, but does not necessarily imply that they liked them sweeter. Results from the tasting of apricots from the Santa Clara district showed no significant effect of age groups. In a consumer taste panel on canned cling peaches *(33)*, the youngest and oldest age groups preferred sweeter fruit than did the two middle groups. It has been reported *(3)* that individuals under 21 preferred sweeter apple juice than did older people. In a large survey on eating habits of older women, Beegle *et al. (4)* found that the amounts of sugar added to beverages, cereal and fruits increased particularly after the age of 50. Harding and Wadley *(17)* submitted oranges to high school students whose scores agreed more closely with the content of solids and acid than did the adults' scores, suggesting keener taste in the younger group. Baten *(2)*, also, has reported that young people distinguish differences between various strengths of materials (tomato juice, apple juice, lemonade) when more mature people do not.

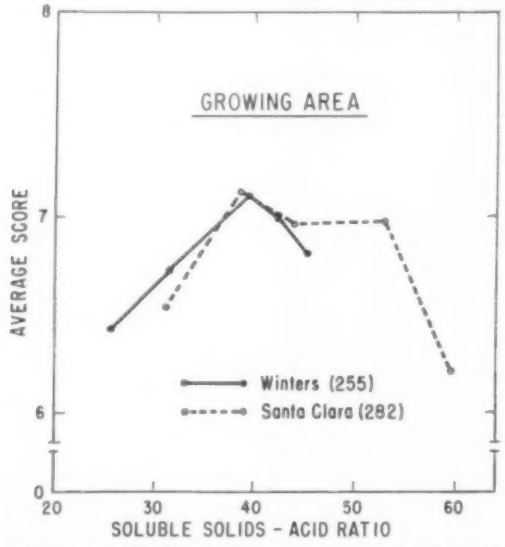

Figure 1. Relationship between acceptance and soluble solids-acid ratio of canned apricots.

Effect of sex. Although the analysis of variance for preference due to sex difference (Table 4) showed no significance, the higher F values and lower standard error for the females' responses (Table 3) indicate that women were more in agreement as a group, i.e., there was less variation in their scores. Previous work has

TABLE 4
Analysis of variance for treatment, sex and age

Source of variation	Degrees of freedom	Winters Area			Santa Clara Area		
		Mean square	F value	L.S.D.[1]	Mean square	F value	L.S.D.[1]
Total	39						
Treatment	4	0.512	8.14***	0.255	1.383	18.22***	0.282
Sex	1	0.133	2.12		0.086	1.13	
Age	3	0.454	7.22***	0.228	0.080	1.05	
Sex x treatment	4	0.062			0.063		
Sex x age	3	0.048			0.103		
Age x treatment	12	0.054			0.076		
Pooled error	31	0.063			0.076		

[1] Least significant difference between means at the 5% level of probability.
***Significant at P = 0.001.

shown that males preferred sweeter canned peaches than did females *(33)*. Langwill *(22)* reported that women have a greater sensitivity of taste in distinguishing between basic tastes (sweetness, saltiness, sourness and bitterness) than men. In the present study, none of the interactions, sex x treatment, sex x age or age x treatment, proved to be significant.

Effect of time of day. The data collected were analyzed to determine whether sweeter apricots were preferred after the noon meal or after the evening meal. The results (Table 5) disclosed that there was no significant effect on sweetness preference as a result of time of day the fruit was tasted. However, Winters apricots at the 50° Brix level received the highest average score at noon, whereas after the evening meal, the 60° Brix level was most popular. Scores for Santa Clara apricots show that the 40° and 60° Brix levels were significantly better than all others at noon, while in the evening, all levels were significantly better than the 70° Brix. The fluctuating scores for apricots tasted at noon could indicate that the 75 evaluations collected was an insufficient number to establish a trend. The results for the noon tasting, especially for Santa Clara fruit, suggest that the opinions were bi-modal, *i.e.*, one group decidedly prefers tart fruit and the other individuals definitely like very sweet apricots.

Effect of body size. The heights and weights collected were compared against standard tables *(22)* of "ideal" weights. Since no information was collected on frame size, weights which fell between the lowest limit for small frame and the highest limit for large frame, were classified as normal. The weight data were not subdivided into percent deviation from normal weight because of the relatively small numbers of individuals involved. The range in percent overweight was 1 to 32% for men and 1 to 61% for women, although a larger percentage of the men were overweight. Overweight was encountered more frequently in men and women over 50 years of age. The incidence of underweight was much greater in women, particularly between the ages of 18 and 35.

Average scores on the apricots, separated into categories according to overweight, normal weight and underweieght, are presented in Table 6. The Winters apricots at 50°, 60° and 70° Brix were scored higher than the two lower sweetness levels by overweight people. The 40°, 50°, and 60° Brix apricots were better liked by the other two weight categories. For Santa

TABLE 5
Effect of time of day on sweetness preference for canned apricots
Average scores

Area	Time of day	In-Going Brix					L.S.D.[1]	Average number evaluations
		30°	40°	50°	60°	70°		
Winters	Noon	7.00	6.97	7.33	6.66	6.75	0.58	75
	Evening	6.30	6.82	7.07	7.12	6.70	0.41	148
Santa Clara	Noon	6.52	7.47	6.77	7.49	6.39	0.55	75
	Evening	6.72	6.98	7.09	6.90	6.10	0.39	148

[1] Least significant difference between means at the 5% level of probability.

TABLE 6
Effect of body size on sweetness preference for canned apricots
Average scores

Area	Body size	In-Going Brix					L.S.D.[1]	Average number evaluations
		30°	40°	50°	60°	70°		
Winters	Overweight	6.57	6.53	7.12	7.44	6.99	0.55	66
	Normal	6.18	7.05	7.78	6.84	6.58	0.44	104
	Underweight	6.88	6.31	7.00	6.31	6.06	1.12	16
Santa Clara	Overweight	5.94	7.29	7.21	7.19	6.67	0.77	38
	Normal	6.71	7.08	6.90	6.94	5.93	0.43	125
	Underweight	6.10	7.47	7.20	7.38	5.81	1.04	21

[1] Least significant difference between means at the 5% level of probability.

Clara apricots, the three middle sweetness levels were scored comparably by the three groups. The reader's attention is called to the average scores assigned to the 70° Brix samples within each growing area. This sample, in both growing areas, was scored the highest by overweight people and the lowest by the underweight consumers. Although the scores represent small numbers of individuals, the slight trend noted could mean that the overweieght person is more likely to accept a very sweet fruit sample. Heavy men and women scored the very sweet samples higher than did underweight consumers or those of normal weight, although they did not necessarily like the sweetest apricots best (Table 6).

Additional observations. Many diversified reasons were given for liking or disliking the apricots tested. A classification of the comments made on the score cards, in order of frequency of appearance, is given in Table 7. The middle sweetness levels received the most favorable comments while the extremes were criticized the most severely. The number of individuals designating the fruit as "flavorless" decreased with increasing sweetness up to the 60° Brix level, while remarks on "good flavor" increased up to the same level. This suggests a definite association between sweetness and apricot flavor intensity as has been reported previously *(36)*. The consumers commented on a more acceptable texture of the fruit with an increase in sugar content. Also, a high color was noticed in the sweeter samples.

It is of great interest to note that comments on bitterness or toughness of the skins, not sweetness or apricot flavor, were responsible for the low scores of relatively large numbers of individuals. Although appearance factors are often mentioned, most of the responses were based on flavor quality, followed by texture of the canned fruit.

SUMMARY AND CONCLUSIONS

Apricots from one of two California growing areas were canned with sucrose syrups of 30°, 40°, 50°, 60°, or 70° ingoing Brix, then evaluated by 537 household consumers. In general, the three middle sweetness levels were preferred over the two extremes, and acceptance could be directly related to the ratio of soluble solids to acid of the canned fruit. Apricot flavor intensity was associated with sweetness to a level of 60° Brix. Although appearance factors such as color and eye appeal were mentioned, most responses were based on flavor quality followed by texture quality.

People under 18 and over 50 scored all samples higher, and females were more consistent as a group than males, however, the effects of age and sex on sweetness preferences were not statistically significant. There was a slight, yet not significant, trend toward accepting a sweeter apricot in the evening than at noon. Overweight people scored the very sweet samples higher than did underweight consumers or those of normal weight.

The results indicated that the hedonic scale with single sample presentation was sensitive enough to obtain significant differences from this untrained consumer panel. A larger population should be sampled before definite conclusions can be drawn concerning the influence of time of day and body weight on sweetness preference.

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TABLE 7

Reasons most frequently given for response to canned apricots (Both growing areas combined)

In-Going Brix									
30°		40°		50°		60°		70°	
Reason	Frequency	Reason	Frequency	Reason	Frequency	Reason	Frequency	Reason	Frequency
Unsweet	75	Good flavor	100	Good flavor	137	Good flavor	188	Too sweet	221
Flavorless	54	Right sweetness	55	Too sweet	62	Too sweet	127	Good flavor	111
Mushy	51	Mushy	42	Right sweetness	56	Right sweetness	83	Good texture	57
Too tart	45	Flavorless	37	Disliked skins	44	Good texture	58	Disliked skins	47
Right sweetness	45	Disliked skins	35	Mushy	32	Disliked skins	56	Good color	42
Good flavor	43	Just right	34	Good color	30	Mushy	36	Right sweetness	42
Too sour	34	Unsweet	26	Flavorless	28	Good color	36	Mushy	33
Disliked skins	32	Too tart	25	Good texture	18	Flavorless	14	Flavorless	21
Green fruit	22	Green fruit	24	Unsweet	17	Good appearance	12	Off-flavor	15
Poor texture	14	Good color	22	Just right	12	Too tart	10	Too sour	11
Bitter	11	Too sweet	20	Too tart	10	Poor texture	9	Poor texture	10
Too acid	7	Too sour	14	Bitter	10	Green fruit	8	Nice appearance	8

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The Role of Enzymes in Food Flavors[a, b]

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THE SCIENCE OF FOOD PROCESSING is today much concerned with problems of flavor. These problems relate to objectives which fall roughly into three groups, depending upon the type of food and the aims of the food processor: (a) to present to the consumer food that is instantly recognizable as fresh, (b) to prepare food so that it has the flavor of freshly prepared fresh food, and (c) to prepare food which conforms to the consumer's notions of desirable flavor.

The purpose of this paper is to summarize the important aspects of flavor development in foods and to outline a method of flavor restoration in processed foods.

The flavor concept in nature. Characteristic flavors (odor and taste) of fruits, vegetables, other fresh foods, and fresh biological materials are due to chemical compounds produced by the organisms as a result of its normal metabolic processes. Presumably such flavors have been formed from other chemical substances, which can be called flavor precursors. The flavor precursors have themselves been formed from their precursors, making it possible to picture the formation of a series of chemical substances in a chain of reactions which might begin with carbon dioxide, sunlight, water, and minerals.

These chemical changes are brought about by the catalytic effect of enzymes, the naturally occurring proteinaceous materials found in the organism. Enzymes are often highly specific for bringing about the chemical changes in each step of the complicated process whereby the flavor precursor is built up and then converted into the flavor itself. These enzymes are heat sensitive and lose their ability to catalyze chemical reactions on being heated. They can also be inactivated by other means, such as irradiation or "poisoning" by certain chemical compounds.

Flavor as a processing problem. Processing food is basically a stabilizing process. Stabilizing is achieved by substantially destroying or inactivating all the enzymes. This is most commonly done by a heat process, blanching, in which the food is subjected to wet heat consisting usually of hot water or steam. The blanched food is then subjected to further processing (such as freezing, canning, dehydration) to prevent or retard chemical changes and growth of bacteria on storage.

Result of the process is that the food no longer contains active enzymes. Depending upon the methods of processing, there will be other changes from the fresh food, some additive, some subtractive in nature. As far as flavor is concerned, the effect is deleterious because many of the flavor components are volatile or heat labile. Thus, in the study of food products it is important to determine what part the flavors of the fresh food (that is, the enzymatically produced flavors) play in the desirable flavors of the food or food products as presented to the consumer. The flavor of processed foods may be compounded of the fresh flavor which has persisted through processing, flavors which come from conversion of the fresh flavors originally present, and flavors which arise during processing.

Utilization of "latent" flavor sources. Non-volatile, relatively heat stable compounds present in the food will survive processing, and among these will be the flavor precursors. It follows, then, that the flavor precursors which survive processing represent a source of latent or potential flavor. If this potential can be converted to flavor, a valuable improvement in the processed food will have been made. We have found that these sources of flavor in processed foods can be converted into actual flavor by the addition of the proper enzymes, the isolation and characterization of which have been tasks of considerable complexity. It is not possible within the limits of the present article to trace the course of this work.

Illustrated graphically in Figures 1 and 2 is the abstract model of flavor development and restoration.

Flavorese. The enzyme(s) necessary for conversion of the flavor precursor(s) to the flavor(s), we have called "flavorese" enzymes.[c] These flavorese enzymes can be obtained from the fresh biological material before processing, or from a biologically related source, by one of the usual processes for the preparation of enzymes.

It is not necessary to obtain an absolutely pure sample of flavorese enzyme, since a relatively crude enzyme preparation will be effective if it contains a high enough concentration of the desired enzyme. If, however, it contains some unwanted enzymes (not concerned with the formation of fresh flavor), then it would be desirable to add the crude enzyme just prior to the preparation of the food for consumption. The specificity of the flavorese enzymes is indicated by the fact that none of the readily available industrial enzymes gave the same effects as the flavorese enzymes.

[a] This work was carried out under contract with the Quartermaster Research and Development Command, Natick, Massachusetts. It is part of a continuing study of the flavors and off-flavors of fruits and vegetables. The first part of this research was reported at the 129th American Chemical Society meeting in Dallas, April, 1956.

[b] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 13, 1956.

[c] The suffix, ese, indicates that the enzyme(s) are concerned with the formation of flavors. The more commonly used suffix, ase, refers to the nature of the substrate upon which the enzyme acts.

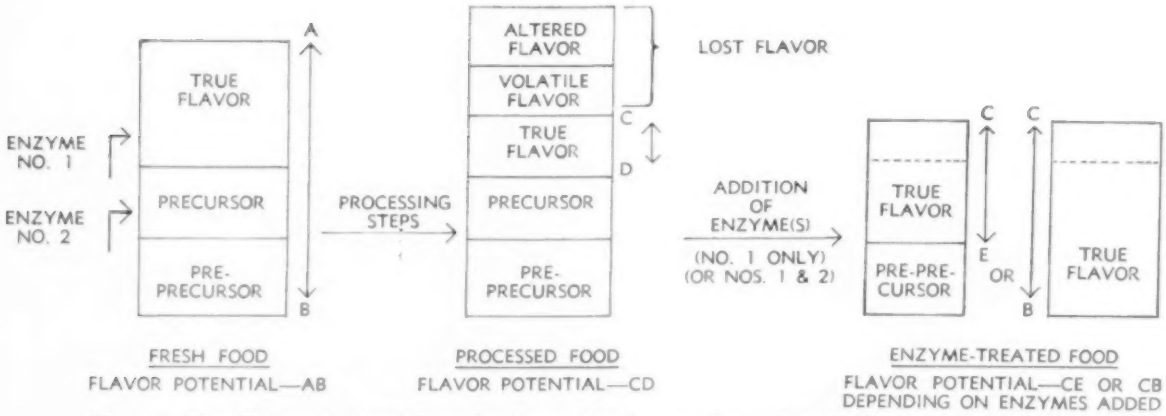

Figure 1. Flow diagram of natural flavor development, loss in processing, and restoration by enzyme additive.

EXPERIMENTAL RESULTS

Fresh watercress was blanched in steam and dehydrated in an oven at about 60° C. for 3 hours. The dehydrated material was quite flavorless and had none of the characteristic taste and smell of watercress. When water was added to this material, no change was observed. The reconstituted watercress smelled and tasted like hay.

However, when a tasteless, odorless, enzyme preparation from white mustard seeds (white mustard and watercress both belong to the *Brassica* family) was added to the dehydrated watercress in water, the typical odor and taste of watercress was regained within a few minutes. Enzyme preparations from black mustard seed and cabbage seed were also effective.

Using the same enzymes, a similar effect was obtained with dehydrated cabbage. Other materials, such as celery, leek, spinach, pineapples, onions, tomatoes, oranges, bananas, parsley, strawberries, milk, and carrots, have been shown to be capable of similar improvement by the use of the appropriate enzymes.

Since the presence of the precursor is required in the processed food for the effect of enzyme addition to be observed, it is clear that for maximum effect the conditions of processing must be such that the precursor is preserved throughout processing to the greatest possible extent. Thus it may be more desirable to plan the processing treatment with the intent of securing the maximum precursor survival than to plan for the maximum flavor survival.

This is illustrated by the case of watercress. The enzyme in watercress responsible for converting the precursor to the flavor is very heat labile and the conditions of dehydration (60° C.) are sufficient to inactivate it. Thus, when watercress is dehydrated without previous blanching, the product is flavorless, and rehydration brings back no flavor. When dehydrated unblanched watercress is compared with dehydrated steam-blanched watercress and with dehydrated boiling water-blanched watercress, all are found to be bland and flavorless. However, when the white mustard enzyme preparation is added to the water of rehydration, a marked difference appears. The unblanched quickly regains its strong taste and smell. The steam-blanched has, by comparison, a moderately strong regain, and the boiling water-blanched has only a weak regain of characteristic flavor. Moreover, the water

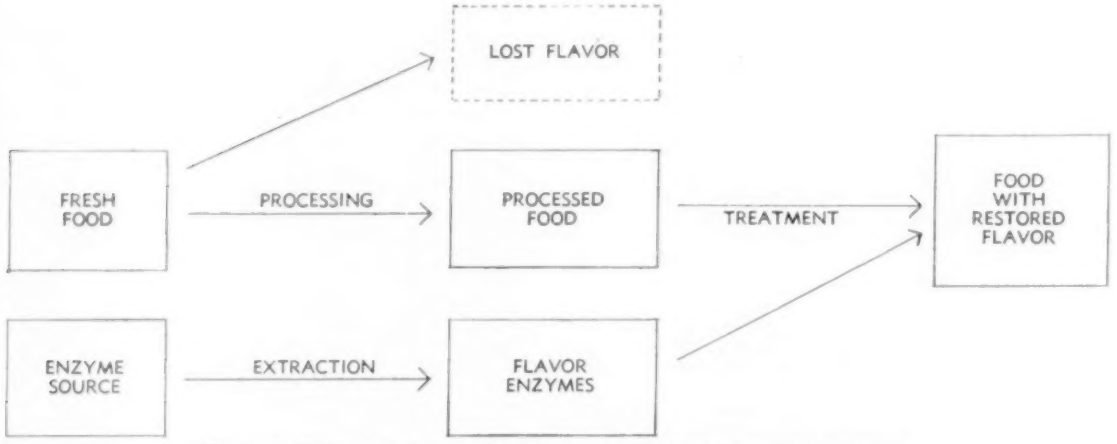

Figure 2. Restoration of natural flavor to processed foods by enzyme treatment.

used for the hot water blanch is quite flavorless, but on treatment with the enzyme soon develops a strong watercress flavor. This proves that hot water-blanching has leached out the precursor and reduced the potential flavor of the processed watercress. It also shows that steam blanching is to be preferred in this case although even this leads to slight losses.

CONCLUSION

An understanding of these principles can be of great advantage in designing conditions for the commercial processing of foods. Severe flavor losses may be tolerated in order to preserve the precursors; the latent flavor from the precursor more than compensates for the flavor loss.

Dehydrofrozen Apricots—Preparation[a]

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(Manuscript received April 28, 1956)

DEHYDROFREEZING, OR PARTIAL DEHYDRATION followed by freezing, has as its objective the preservation of whole or cut fruits and vegetables in such a manner that the maintenance of top quality is combined with economies in weight, volume, packaging, transportation, and storage. Dehydrofrozen apricots at a level of 50% weight reduction are eminently suited for use in attractive and well-flavored pies and preserves. They are free from browning, which sometimes occurs on the surface of frozen fruit, are devoid of free-run juice after thawing, and can be packed without any added sugar or sirup. Browning can be prevented by treating the fruit with sulfur dioxide solutions before drying. A major portion of the sulfur dioxide retained in the treated fruit is driven off during dehydration. The frozen material contains only sufficient sulfur dioxide to protect the bright, natural color of the fruit. Following subsequent rehydration for use in pies or preserves, the final levels of sulfur dioxide in these products is usually well below the taste threshold of the average person.

The process of dehydrofreezing is particularly important to the apricot industry. Practically all apricots packed for remanufacture into preserves and pies originate in California but are utilized throughout the country. Hence, container, storage, and shipping costs constitute a major expense to the average baker or preserve manufacturer. Dehydrofrozen apricots offer the manufacturer the potential advantage of good quality at a substantial saving in cost.

Application of the process to various fruits and vegetables has been reported in several previous articles. Howard and Campbell *(2)* and Legault and Talburt *(1)* discussed the general principles of the process; Talburt and Lindquist *(8)* have reported progress in development of dehydrofrozen products. Processes for dehydrofreezing two specific foods have been reported: for peas by Talburt and Legault *(7)* and for apple slices by Talburt, Walker, and Powers *(9)*. A public service patent on the process was issued in 1949 to Howard, Ramage, and Rasmussen *(3)*.

This paper discusses selection of fresh apricots, inactivation of enzymes, procedures for dehydration, and methods for utilizing this product in preserve and pie manufacture. The results of commercial tests on preparation of dehydrofrozen fruit and a comparison of dehydrofrozen with conventionally-frozen apricots for use in pies and preserves are included.

EXPERIMENTAL DEVELOPMENT

Fresh material. Five varieties of apricots (Blenheim, Tilton, Hemskirk, Royal, and Moorpark) were successfully dehydrofrozen during these experiments. The most intensive work was done with Blenheim, since it is widely used in processing and has a bright, golden-colored flesh and a rich flavor. Maturity was found to be an important factor in quality of product. Fruit of good color and slightly soft texture, equivalent to what is termed "freezing ripe" by the trade, produced the best product. Greenish fruit was unsuitable, because heat treatment in the process is too mild to affect color of the flesh, while soft-ripe fruit tends to mush badly. In products intended for preserve manufacture, special care was taken to eliminate fruit showing dark-colored skin blemishes, because such blemishes are readily apparent in the finished preserves.

Cause of browning. The tannin content in apricots is correlated with tendency to darken and is much higher at or near the skin layer than in the main body of flesh. As an example, the tannin content in Blenheim apricots as determined by titration with the Folin-Denis reagent *(6)* was 60 mg./100 g. for the flesh and skin, 40 mg. for the flesh only, and 370 mg. for the skin area. The higher tannin content of the skins indicates that stronger treatment to prevent discoloration is required for the skin area than for the main body of flesh. A secondary concentration of tannins was found adjacent to the pit area. Hence, various treatments were designed and tested for retention of bright color in the critical areas while avoiding overtreatment which might degrade quality within the major flesh areas. These treatments included the use of sulfur dioxide solutions, bisulfite solutions, sulfur dioxide gas, and steam blanching.

Treatment with sulfur dioxide solutions. The most satisfactory method found to prevent darkening consisted of a two-step sulfiting process. Aqueous sulfur dioxide solutions were used and the stronger, initial sulfite treatment was directed against the skins of the whole, uncut apricots while the weaker treatment was directed against faces of cut halves.

In laboratory tests, whole apricots were dipped for 2 minutes in an aqueous solution containing 1.5% of sulfur dioxide at room temperature (65° to 75° F.). This treatment introduced only a small amount of sulfur dioxide, but it was concentrated near the surface and was sufficient to prevent darkening in the skin area during dehydration. Whole, sulfited apricots were cut, pitted, and given a second dip of approximately 15 seconds in an aqueous solution containing 0.4% of sulfur dioxide. Small stainless-steel baskets containing the fruit were immersed in stainless-steel tubs containing the sulfite solutions. Following the second dip, baskets were tipped and rotated to drain off the sulfite solution trapped in those halves facing upward.

The sulfur dioxide concentration in dip solutions was determined by titration with 0.1*N* iodine solution and use of a starch

[a] Presented at the Fifteenth Annual Meeting of IFT, June 15, 1955, Columbus, Ohio.

indicator. That in dehydrofrozen fruit was determined by the gravimetric, Monier-Williams procedure *(1)*. The approximate level needed in laboratory trials, consistent with bright, high-quality dehydrofrozen apricots, approximated 150 p.p.m. of sulfur dioxide.

Sodium bisulfite solutions, acidified or otherwise, of equivalent concentrations were used but were found to be ineffective, very probably because of the higher pH and lessened activity of these solutions. As the objective is primarily to obtain maximum sulfite penetration in the minimum amount of time, particularly through apricot skins, the use of solutions which produce lower rates of penetration than sulfurous acid solutions is not recommended.

Other treatments to control browning. Prevention of browning was attempted by use of sulfur dioxide gas, by heat inactivation of enzymes, and by use of whole, unpitted apricots.

Direct sulfiting with sulfur dioxide gas is commonly used when high concentrations in the fruit are needed, as in fruit intended for sun drying. However, experiments designed to provide impregnation at the lower levels required for dehydrofreezing were unsuccessful because of lack of uniformity of absorption. Steam scalding also was investigated. Apricot halves were scalded, cups upward, on stainless-steel wire-mesh trays. The minimum treatment required to prevent enzymatic browning (4 minutes at 212° F. or 7 minutes at 190° F.) was determined by the catechol test *(5)*. The fruit softened noticeably, became duller in color during the treatment, and produced a less attractive product.

Moisture reduction. Relationships between various drying conditions and product quality were determined by laboratory trials. These tests were made in a forced-draft cabinet drier equipped with suitable temperature and humidity controls. Air velocity in the drying zone was approximately 900 feet per minute. Sulfited apricot halves were uniformly distributed in a single layer, with cut portions upward, on stainless-steel wire-mesh trays. The initial weight of fruit approximated 2 pounds per square foot. Uniformity of drying was aided by slightly inclining the trays toward the air stream. Degree of weight reduction was determined by weight loss of each tray of fruit.

Dehydration temperatures were varied from 140° to 240° F. dry bulb and 90° to 130° F. wet bulb. Good products were obtained at 50% weight reduction with dry-bulb temperatures as high as 220° F. Similar products at 65% weight reduction could be obtained, provided dry-bulb temperatures were reduced to 185° F. during the latter part of the cycle. Use of wet-bulb temperatures higher than those naturally occurring in the drier (135° instead of 95° F.) did not significantly reduce the SO_2 content of the fruit or otherwise affect its quality. Size comparisons of typical apricot halves before and after drying are shown in Figure 1. Results of these studies indicate that a consistently good product can be obtained in about 60 minutes by dehydration to 50% weight reduction at dry-bulb temperatures of not over 200° F. and wet-bulb temperatures of 85° to 105° F.

Various kinds of driers have been used, including cabinet, cross-flow tunnel, through-flow tunnel, and rotary louvre and cage types. All of the driers that employ drying trays have worked very well and can be recommended. However, the rotary types tested were found to be unsuitable because the agitation and rolling caused marked crushing of fruit and leakage of juice.

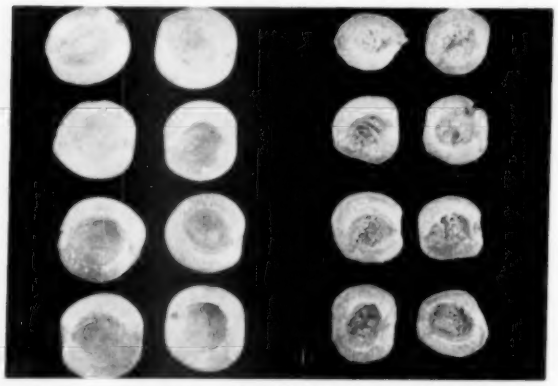

Figure 1. Comparison of undried apricot halves (left) with apricot halves of 50% weight reduction (right).

Packaging and freezing. A greater density in the package can be obtained by bulk rather than by tray freezing, because the fruit can be compressed to give practically a solid pack. Thirty-pound enameled friction-top cans, smaller enamel-lined sanitary-type cans or cardboard boxes with suitable liners can be used, since the product is practically free from "leakage." Thirty pounds of dehydrated fruit can be readily pakced in a 30-pound can, because no sugar is needed. Reasonably prompt packaging and freezing are desirable for the best protection of color and weight reduction. After packaging, the residual sulfur dioxide present helps to preserve color so that fairly slow freezing rates can be tolerated. Stability of the frozen product at 0° F. or below has been found to be very good. Samples held at 0° F. for 2 years showed no noticeable loss in quality. Tray freezing in an air blast at —10° F. produces an equally good product.

USES FOR THE PRODUCT

Comparisons were made in the laboratory to determine the suitability of this new product as a substitute for conventionally frozen apricots in pie and preserve manufacture. In each case comparisons were made between samples prepared from the same lot of raw material. In the course of these studies, it was necessary to modify standard procedures to some extent in order to effect necessary rehydration of the dehydrofrozen material. Pies and preserves made from dehydrofrozen apricots were found to be superior in some and equal in other respects to those made from conventionally frozen fruit.

Suitability as pie stock. Two types of frozen apricots were compared with 3 types of dehydrofozen fruit. The former were prepared as follows: (a) Sulfited: This was accomplished by a 5-minute immersion of freshly halved apricots in a 0.20% sulfur dioxide solution, followed by draining for a half minute prior to packaging in enameled No. 2 cans and freezing at —10° F. (b) Light steam scald plus ascorbic acid and salt: Halves were steamed for one minute at 212° F., dipped in a solution of 3.0% ascorbic acid and 2.0% sodium chloride, and then packaged in enameled No. 2 cans and frozen at —10° F.

Sulfited dehydrofrozen apricots (50% weight reduction) were prepared by the procedure recommended above, except that one lot was frozen in No. 2 enameled cans and the other was tray-frozen at —10° F. prior to packaging in No. 2 enameled cans. Steam-treated, dehydrofroezn apricots were prepared by spreading halved fruit in a single layer on stainless-steel trays, cups upward, steaming for 4 minutes at 212° F., and drying. The product was packaged in No. 2 enameled cans and frozen at —10° F.

All samples were stored for 5 months at 0° F. before appraisal. In pie preparation, all samples were treated identically after additional water needed for rehydration had been added to the dehydrofrozen samples. The prepared pies were appraised by 10 persons. Several replications were run on each of the possible combinations. For record purposes, the judges were asked to assign numerical values to their opinions on color, general appearance, texture, and flavor.

The organoleptic tests showed: (a) Pies made from sulfited dehydrofrozen apricots were as good as those made from conventionally frozen apricots. (b) Steam-treated dehydrofrozen apricots were fairly good but inferior to the sulfited dehydrofrozen fruit in both flavor and texture. (c) Tray freezing, instead of solid-pack freezing, offered no important advantage for these two dehydrofrozen types.

The following formula for pies has been found to produce a very satisfactory product:

Dehydrofrozen apricots, of 50% weight reduction	20 oz. (320 g.)
Water	30 oz. (480 g.)
Sugar	9 oz. (144 g.)
Cornstarch	1.5 oz. (24 g.)

Mix a small amount of water with cornstarch to make a slurry. Heat remaining water to boiling. Stir in sugar and starch slurry. Combine the thawed apricots with the boiling sirup and boil for one minute. Cool mixture and place in 9½-inch pie shell. Bake.

Suitability for preserve mnafuacture. Usual preserve-making procedures were adapted to this new product. Dehydrofrozen halves were warmed to 10° F. and diced, in order to give the desired piece size in the preserves. As it was necessary to add rather than evaporate water, the usual boiling period could be shortened substantially. The problem of causing sufficent sugar absorption by the apricots to assure uniform distribution in the finished preserves was solved by a holding period at 190° F. prior to filling. The following ingredients were used:

Dehydrofrozen apricots of 50% wt. reduction (diced to ½ × ¼ × 3/16 inch)	3.75 lbs.
Water	4.0 lbs.
Sugar (common sucrose)	9.0 lbs.
Powdered pectin, 150 grade, rapid set (amount of pectin varies with fruit and desired texture of preserves)	0.21 oz. (or 6 g.)
50% ctiric acid solution	1.5 fluid oz. (or 45 ml.)
Boil to final solids, by refractometer, of	68° Brix

The following procedure was developed: (a) Add water to steam-jacketed kettle; bring to boil. (b) Mix 5 to 10% of sugar with total pectin; dissolve in boiling water. (c) Add fruit; then add remainder of sugar slowly, with stirring. Reheat to boiling and boil 5 minutes. (d) Cool to 190° F., hold for one hour at 190° F., and add citric acid by gentle, thorough stirring. (e) Fill jars, steam-flow seal, hold, and water-cool, by simulated commercial procedure.

Apricot preserves made from dehydrofrozen apricots offer several advantages to the preserve manufacturer. Piece size in the finished product can be controlled by the size of dice used. Elimination of the need for evaporation of surplus water results in greater flavor retention, less heat damage to color and flavor, and improved shelf life of product. Comparisons with conventionally prepared preserves showed that the color was brighter, the flavor stronger and more nearly like that of fresh apricots, and that the eye appeal of the pack was enhanced through control of piece size. Sulfur dioxide values *(1)* of preserves prepared in the laboratory from commercially dehydrofrozen fruit have ranged from 25 to 45 p.p.m., with an average of 37 p.p.m. The U. S. Food and Drug Administration's definition of standards of identity for preserves and jams as revised in 1952 *(10)* stipulates use of fresh, frozen, and/or canned apricots. The question whether dehydrofrozen apricots can be used in preserves, together with samples of preserves made from dehydrofrozen fruit, has been submitted to the Food and Drug Administration for consideration. This agency has stated that while preserves made from dehydrofrozen apricots do not comply with identity standards, which do not include fruits treated with sulfur dioxide, interested preservers may apply for temporary permits which would allow shipment of these preserves in interstate commerce.

COMMERCIAL TRIALS

Laboratory procedures for producing dehydrofrozen apricots were modified to some extent in tests performed by two commercial packers. A stronger solution (2.5%) and longer time (2.5 minutes) were used for the first dip to compensate for delays inherent in handling large quantities of fruit. The second dip was replaced by a spray technique. Trays of halved fruit were passed under a "curtain" spray of 2.5% sulfur dioxide solution (Figure 2). The sprays consisted of

Figure 2. Spray-sulfiting of cut surfaces on apricot halves prior to dehydration.

a single row of 4 fan-spray-type nozzles, each of which sprayed a width of 10 inches to a total overall distance equal to the width of a 36-inch tray. The rate of spray application on the trays was 0.2 gallon per minute per foot of tray width. The speed of the belt which carried the trays under the nozzles was set at 10 feet per minute. Treated halves were dried for about 2.5 hours on 3 x 8-foot wooden trays in a commercial prune-drying tunnel at not over 200° F. dry-bulb temperature. Several small, perforated aluminum check trays were distributed on each truck load in order to measure the rate and uniformity of moisture loss. The product was detrayed within about 30 minutes after completion of dehydration, packed in 30-pound cans and frozen. The

sulfur dioxide content in the product needed to prevent browning subsequent to dehydration under plant conditions was generally around 200 to 250 p.p.m., by gravimetric procedure *(1)*, when processing operations were performed at moderate speed during hot weather.

Some care may be needed to provide uniformity of drying in tunnels, but this could be accomplished by installation of suitable baffles, static screens, etc.

Trial packs of preserves from dehydrofrozen apricots have been made by two commercial packers. Color, flavor, and texture were all good. Color was slightly brighter and texture somewhat firmer than that of preserves made from solid-pack, canned fruit.

SUMMARY

A process has been developed and described for the production of dehydrofrozen apricots of bright color and rich flavor. The process involves a two-step sulfur dioxide treatment, followed by drying on trays to 50% weight reduction. The second step of the sulfite treatment has been adapted to a continuous spray application, and the process has been tested on a commercial basis. Formulas have been developed and are presented for use of dehydrofrozen apricots in the preparation of pies and preserves. Dehydrofrozen apricots as ingredients are not included in Federal Standards of Identity for preserves established by the U. S. Food and Drug Administration. Temporary permits can be requested for their use in preserve manufacture.

Acknowledgments

The authors wish to express their appreciation to D. G. Guadagni for data on tannin analyses and to E. F. Potter and Elizabeth A. McComb for sulfite analyses. Appreciation is expressed to Virginia G. Cushman and to N. Jean Downes for preparation of pies.

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Effect of Temperature and Relative Humidity on the Rate of Defrosting Of Commercial Bread[a]

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Rate of defrosting is widely recognized as one of the most important factors to be considered when freezing bread for commercial or domestic use *(1, 2, 4, 5, 11, 12)*. A recent report from this laboratory presented experimental verification and specific measurements showing the increase in crumb firmness as defrosting was prolonged *(9)*. Little information exists, however, that shows how fast bread will defrost under the range of temperature and humidity conditions apt to be encountered in commercial practice.

Cauble and Murdough *(2)* very recently performed extensive defrosting tests under controlled temperature and humidity conditions but presented time-temperature curves for only a limited number of bakery products under the optimal conditions found. These were 100° F., 50% relative humidity, and a minimum air velocity of 200 feet per minute. Bread defrosted in 90 minutes under these conditions and was in the staling range only 30 minutes. These findings confirm the preliminary reports from this laboratory *(7, 8, 9)* which gave defrosting results obtained with combinations of two temperatures and two humidities for wrapped and unwrapped bread. Cathcart *(4)* recently presented defrosting curves for frozen bread packed in corrugated shipping cartons. Firmness readings clearly showed the disadvantages of the slow defrosting as compared to defrosting of individual loaves.

The present report includes results for additional temperature and humidity conditions so as to represent reasonably well the range of conditions apt to be encountered commercially. Some observations are also presented concerning the use of microwave heating for rapid defrosting of bread.

MATERIALS AND METHODS

The defrosting experiments were conducted in a test-baking fermentation cabinet equipped for automatic control of both temperature and relative humidity over a small range of conditions. For the higher relative humidities and temperature conditions desired, however, a supplementary heating coil was required to provide the desired controlled temperature. A supplementary fan was also necessary to provide a nominal air

[a] Presented in part at the Sixteenth Annual Meeting, Institute of Food Technologists, St. Louis, Missouri, June, 1956.

velocity of approximately 150 linear feet per minute that was uniformly distributed in the empty compartment used for the frozen bread during the runs. Relative humidities were determined by wet and dry thermocouples in the chamber, with the wet thermocouple exposed to a local air velocity of about 400 feet per minute by means of a separate small blower.

Temperatures at the center of the loaves were determined and recorded automatically as described previously *(6)*. Defrosting time was defined as the time necessary for the temperature at the center of the loaves to increase from 0° F. to 70° F. Duplicate thermocouples were placed in the bread before freezing at −20° F. (approximately 90 minutes were required); the bread was then equilibrated at 0° F. at least overnight before being used in the defrosting runs. Experiments were run at least twice and with duplicate loaves for each run.

The bread used was unsliced, white, round-top (22.5 oz.) and was obtained from either of two commercial bakeries about 2 hours after baking. Bread from the different baking companies gave essentially identical results and was used interchangeably. Most experimental runs included both unwrapped loaves and loaves wrapped in the usual type of waxed paper. Firmness measurements were made with a Baker compressimeter,[b] as described previously *(9)*. Values represent averages for 10 slices from the center of each of 3 replicate loaves.

RESULTS

Effects on defrosting rates. The results plotted in Figures 1 to 3 show the effects of 3 temperatures, each at 3 humidity levels, on the rate of defrosting of both wrapped and unwrapped bread. As would be expected, a more or less regular decrease in defrosting time accompanied each increase in temperature, and the presence of a wrapper significantly slowed defrosting. Less regular increases in defrosting rate accompanied the increases in relative humidities at the various temperatures. In fact, no increases occurred in some cases.

As would be readily predictable from consideration of heat transfer fundamentals, defrosting of both wrapped and unwrapped bread was proportionally faster when the air temperature was raised from 80° to 100° F. than when it was raised from 100° to 120° F., while keeping relative humidity constant. This is more clearly shown in Figure 4 where results are plotted for a single relative humidity level. With wrapped bread, for instance, the defrosting time decreased 66 minutes when the temperature was raised from 80° to 100° F., but a further decrease of only 42 minutes resulted from raising the temperature from 100° to 120° F.

[b] Mention of trade name does not imply endorsement by the U. S. Department of Agriculture.

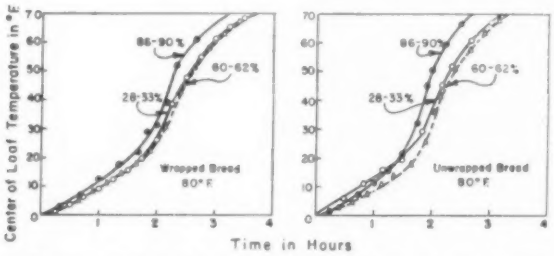

Figure 1. Effect of three relative humidity levels on the rate of defrosting bread at a low air temperature (80° F.) and low air velocity (150 ft./min.).

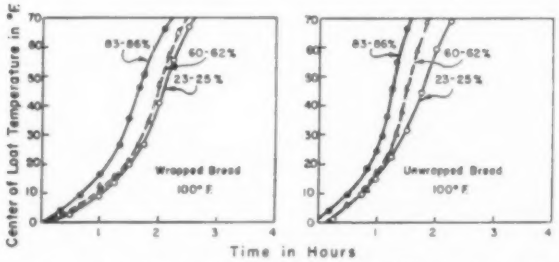

Figure 2. Effect of three relative humidity levels on the rate of defrosting bread at an intermediate air temperature (100° F.) and low air velocity (150 ft./min.).

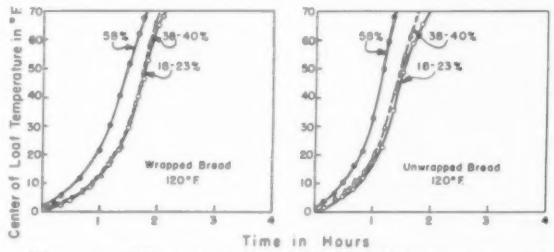

Figure 3. Effect of three relative humidity levels on the rate of defrosting bread at a high air temperature (120° F.) and low air velocity (150 ft./min.).

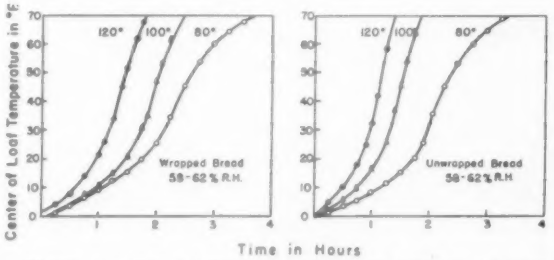

Figure 4. Effect of three air temperature levels on the rate of defrosting bread at an intermediate relative humidity and low air velocity (150 ft./min.).

A substantial portion of the increase in defrosting rate obtained by raising the temperature, but keeping *relative humidity* constant, was probably due to the consequent increase in moisture content of the air used for defrosting. The *specific* or absolute humidity (actual moisture content) of the air increases by almost a factor of 2 for each 20° F. increment of temperature in the range used, when relative humidity is kept constant *(13)*. The heat content of the air is thereby increased significantly beyond the amount it would have been increased merely by warming the air and allowing the relative humidity to fall accordingly. The calculated enthalpy values *(13)* shown in Table 1 illustrate these considerations a little more clearly.

TABLE 1

Calculated approximate enthalpy changes of the air[1] used for defrosting bread when the moist air is warmed with and without added extra moisture to keep relative humidity constant

Temperature change, ° F.	Relative humidity, %		Enthalpy increase
	Initial	Final	BTU/lb.dry air
80 to 100	60	60	19
80 to 100	60	32	5
100 to 120	32	16	4
100 to 120	60	60	31
100 to 120	60	34	7

[1] Considered as mixture of dry air and saturated steam *(13)*.

Figure 5 shows the defrosting rates determined in this study that correspond approximately to the situation where air is warmed from 80° F. and 60% relative humidity (not uncommon summer conditions in many parts of the country) to 100° and 120° F., with resulting decreases to about 32% and 16% relative humidity, respectively. The defrosting rates, of course, increased substantially as the air temperature was raised, although not as much as if relative humidity had been kept at its original level.

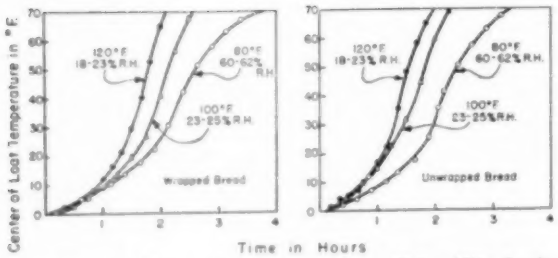

Figure 5. Effect of air temperature and humidity levels simulating the warming of low temperature air of intermediate relative humidty on the rate of defrosting bread at low air velocity (150 ft./min.).

A satisfactory explanation of the effect of humidity on defrosting rates is quite complex and would be difficult to predict accurately from heat transfer fundamentals, alone. The following factors, for instance, affect the extent to which the higher heat content of more humid air can be realized to reduce defrosting time: (a) differences in warming effects resulting from differences in amounts of water condensed (and possibly frozen) on the loaf or wrapper, (b) differences in cooling effects caused by differences in evaporation of condensed moisture from the loaf or wrapper, and (c) differences in resistance to heat flow caused by differences in condensation and evaporation at the loaf or wrapper surfaces.

Commercial operators would hardly be expected to increase the moisture content of defrosting air because of the extra cost involved and because of other troublesome features discussed below. The point is, however, that heavily moisture-laden air is not necessarily a disadvantage. Also, partial control over humidity can easily be obtained by control of the air temperature.

Effects on crust and wrappers. Gain or loss of moisture during and after completion of defrosting depend not only on the temperature and humidity of the air and on temperature of the object being defrosted, but also on the time that the object being defrosted is exposed to the air used for defrosting. Copious condensation of moisture during early phases of defrosting will be followed by evaporation of at least part of the condensed moisture before defrosting is completed. Some experimental determinations of net weight changes for unwrapped bread during defrosting are shown in Table 2. Weight changes for wrapped bread under the same conditions were negligible (ranging between 1 and 5 grams per wrapped loaf), provided that condensed moisture on wrappers from defrosting at high relative humidities was wiped off with a towel before weighing. Although absorption of moisture by the wrapper itself seemed slight in these cases, it should be pointed out that any extra moisture taken up by the wrapper at all will intensify the possibility of damage to the appearance of the wrapper caused by handling.

TABLE 2

Weight changes in grams per loaf (22.5 oz.) of unwrapped, unsliced bread during defrosting under various conditions of temperature and relative humidity

Approximate relative humidity, %	Temperature, °F.		
	80	100	120
23 to 33	−14	15	−15
38 to 40	—	—	−7
58 to 62	—	2	14
83 to 90	17	30	28

Results in Table 2 show that unwrapped bread will lose serious amounts of moisture during defrosting with dry air, but also that defrosting at higher relative humidities will cause an uptake of enough moisture to cause the crusts of the loaves to be very wet and soggy immediately after defrosting. The best conditions at the low air velocity used (about 150 feet per minute) would seem to be close to 50% relative humidity. On the basis of the results shown in Table 2, neither a final gain nor loss in weight would be expected at this relative humidity level.

Micro-wave defrosting. Despite high initial cost of presently available equipment, the use of micro-wave or high-frequency heating to defrost bread is very attractive for at least 2 reasons: First, the very rapid generation of heat more or less uniformly throughout the loaf, and secondly, an opportunity to "refreshen" the bread by reversing firmness increases unavoidably imparted during the freezing process. The defrosting of bread by this method of heating has already been shown to cause no appreciable transfer of moisture within the loaf *(10)*. Another advantage is a stabilization of the product toward mold growth *(3)*.

In the present experiments, 2½ minutes' exposure of a frozen loaf of bread to micro-wave (2,450 megacycle frequency) energy at a power level of about 750 watts was sufficient to raise the center temperature of the loaf to the range of 120° to 140° F. The hot crumb was quite soft and very like freshly baked, hot bread. After cooling for an hour or two, however, the measured firmness of the crumb was appreciably greater than in the fresh control bread just before freezing—in fact, only a little less firm than in bread after defrosting at room temperature. These comparisons are illustrated in Figure 6, which also shows

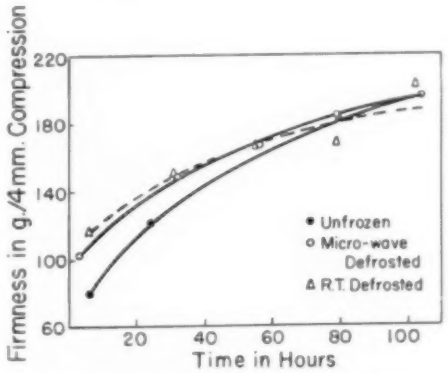

Figure 6. Rates of increase of firmness during storage at 70° F. of unfrozen bread, bread defrosted at 70° F., and bread defrosted by micro-wave heating.

subsequent development of firmness in bread defrosted by the two methods and in unfrozen controls. These results confirm the observation of Cathcart *et al. (3)* that stale bread was incompletely refreshened by micro-wave heating to an internal temperature of 140° F.

Aside from the rapidity of defrosting with micro-wave heating in these experiments, little advantage for the method was demonstrated. The refreshening effect was relatively small, although heating to a higher internal temperature probably would have improved it. This was demonstrated by reheating some of the defrosted bread that had been stored several days at 70° F. A very substantial decrease in firmness resulted—from 155 g. down to 93 g./4 mm. of compression, for one example. A severe limitation to the extent of refreshening that could be given the frozen bread was that wrappers became seriously damaged by too much heating, either from melting of wax or by excessive uptake of moisture from the steaming hot bread by either cellophane or waxed-paper wrappers. With stale bread, already at room temperature, overheating of wrappers for a given heating period was much less serious.

A non-uniformity of heating within the loaves was evident from small, cold or still-frozen spots near the center of the freshly defrosted loaves. In an effort to avoid this, a series of loaves was heated for one minute, allowed to stand for 30 minutes, and again heated in the high-frequency oven for 1½ minutes. This treatment resulted in no greater refreshening effect than that obtained in the preceding experiment, although heat damage to the wrappers was much less.

DISCUSSION

Perhaps the principal problem associated with the defrosting of bread as currently practiced commercially is that of controlling the condensation of moisture on

wrappers. The products themselves are not harmed, but the appearance of the wrapper and, hence, salability of the wrapped product suffers proportionally. Progressive operators are therefore providing controlled environments for defrosting just as is done for the freezing step. The use of warmed air is advantageous in 2 respects. First, defrosting is more rapid and second, relative humidity of the air is automatically lowered. In some systems, of course, further provision to maintain a low enough humidity may be required. As with general air conditioning, this probably can be accomplished by refrigerated condensing coils or by moisture absorbents. The decision as to how much of the gain in defrosting rate obtained by using moist air need be sacrificed for a desired decrease in extent of condensation must be made by each operator on the basis of his own experience and requirements.

The rate of movement of moist air is recognized as a factor that could affect the extent of condensation during defrosting, but little information of a practical nature seems available to the baking industry. For instance, minimum velocities required to prevent excessive condensation for a range of temperature and humidity conditions used for defrosting baked goods would be valuable information for the commercial operator. Again, however, this is a complex situation difficult to predict from theoretical principles, so that experimental determination of net effects would be desirable.

Besides the very rapid defrosting possible with micro-wave energy, another advantage would be that excessive condensation of moisture on outer surfaces of wrappers could be entirely avoided, although similar problems with condensation on inner surfaces might be encountered. Even the latter should not become serious if the items were to be merely defrosted and no attempt, as in the present study, were made to achieve complete refreshening.

The very attractive features of micro-wave heating in the commercial defrosting of bakery goods make its successful adaptation appear to be just a matter of time for development to a stage where large operators, at least, will be able to absorb its high initial cost. Such emphasis on achieving the best method available for defrosting is entirely consistent with the importance of this step in the overall procedure of freezing bread commercially. Improper defrosting can easily destroy any gains in quality preservation obtained by the most strict adherence to good freezing practices.

SUMMARY AND CONCLUSIONS

Both relative humidity and air temperature significantly affected the rate of defrosting of bread. A more or less regular decrease in defrosting time resulted from each increase in air temperature at a given relative humidity, but effects from increases in relative humidity at a given temperature were less consistent and, in general, smaller. Rate increases due to increased relative humidity at a given temperature were caused principally by the increased heat content of the air but modified by other factors in a complex manner.

A loss or gain of moisture by unwrapped bread during defrosting depended on air temperature, relative humidity, and duration of exposure to the defrosting air. Excessive condensation of moisture caused both cellophane and waxed wrappers to be damaged or to become susceptible to damage by subsequent handling, but both types of wrappers can be used successfully for the commercial freezing of bread.

Best overall defrosting results were obtained at 120° F. and 50 to 60% relative humidity. Warming of air for defrosting has the twofold advantage of causing faster defrosting and a lowered relative humidity with less trouble from condensed moisture.

Rapid defrosting of bread to an internal temperature of 120° to 140° F. by micro-wave heating produced incomplete refreshening of the bread and caused marked damage to the wrappers. The partially refreshened bread became firm during subsequent storage at room temperature almost as fast as bread defrosted more slowly at room temperature.

Acknowledgments

The cooperation of the Fairfax Bread Company, San Francisco, California, and the Berkeley, California, plant of the Continental Baking Company was very helpful in providing the baked bread used in these studies. Particular acknowledgment is also given to the interest and encouragement of George Garnatz of the Kroger Food Foundation, Cincinnati, Ohio, and to H. C. Diehl of The Refrigeration Research Foundation, Colorado Springs, Colo.

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Organoleptic Studies of Irradiated Foods[a]

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(Manuscript received June 29, 1956)

THE POSSIBILITY OF STERLIZING FOOD by means of high energy radiation such as gamma radiation from radioactive isotopes or cathode radiation from machine generators has been conclusively demonstrated. It has been obvious from the first, however, that flavor and appearance changes may occur to influence acceptance by either the military or the civilan market *(3)*. Appropriately, the flavor and appearance changes during irradiation are receiving wide attention *(1, 2, 4-6, 8-14)*.

In order to obtain some information on the effect of storage on the organoleptic qualities of irradiation sterilized meats, ground beef, beef tenderloin, cured pork luncheon meat, and ham in 211 x 300 cans were sterilized by irradiation, stored at 40°, 70°, and 98° F. and examined at periods up to three years. To obtain similar information on vegetables, irradiation sterilized asparagus, broccoli, brussels sprouts, cauliflower, and peas in 211 x 400 cans were stored at 40° F. and 70° F. and have been examined at periods of up to one year. Green beans in 303 x 406 cans were stored for periods up to nine months at 98° F.

EXPERIMENTAL

Ground beef samples were prepared by grinding choice beef, vacuum mixing, and stuffing into 211 x 300 C-enamel cans at refrigerated temperatures and vacuum closing. Some of these samples were prepared with 1% added sodium ascorbate during the vacuum mix.

Beef tenderloin in 7½ oz. pieces was forced into 211 x 300 cans and injected at several points with 50% sodium ascorbate solution by hypodermic to a level of 1% sodium ascorbate in the total product. The cans were vacuum closed and held at 40° F. for 2 days to permit redistribution of the sodium ascorbate.

Canned ham cut in 7½ oz. pieces was similarly filled and injected with sodium ascorbate solution, vacuum closed and held before irradiation.

Washed fresh asparagus spears were prepared for irradiation in a variety of ways to determine the effect of packing procedure on irradiated product quality. Blanch periods from zero to 20 minutes at 200° F. were used to inactivate enzymes. Spears were filled into 211 x 400 cans with brine and exhausted to 140°-180° F. before closure, sodium ascorbate being added to a level of .1% of the total contents of some cans. A series of cans was also closed under 23-25 inches mechanical vacuum, some with no brine added to the spears.

Washed, trimmed fresh broccoli was blanched 5 minutes at 200° F. and vacuum closed in 211 x 400 cans without brine.

Washed, trimmed cauliflower florets were packed in the same manner as the broccoli.

Frozen brussels sprouts were filled directly into cans and vacuum closed.

Fresh peas were shelled, washed, blanched 3 minutes at 200° F. and vacuum sealed in 211 x 400 cans without brine.

Green beans which had received a blanch of 3 minutes in water at 185° F. on a commercial green bean line were sealed with and without salt brine under steam flow closure.

All products were held under refrigeration prior to irradiation. For comparative purposes samples of each of these products were held frozen or thermally processed or both.

All products except green beans were subjected to 2.6 million rep gamma radiation at the large cobalt-60 source at the University of Michigan Fission Products Laboratory. This dose was calculated from ferrous-ferric dosimetry using the relationship that 16.4 micromoles ferric ion per liter produced is equivalent to 1,000 rep *(15)*.

The containers were held at refrigerated temperatures during irradiation in a specially constructed insulated box surrounding the source. Refrigeration was provided by cans of frozen water or blocks of dry ice depending on the temperature desired.

The green beans were subjected to 3 million rep gamma radiation from spent fuel elements at Arco, Idaho, under the auspices of the Quartermaster Food and Container Institute for the Armed Forces.

The pork luncheon meat and some samples of ground beef and beef tenderloin were heated to 160° F. can center temperature to inactivate enzymes prior to storing.

The irradiated samples were stored under closely controlled temperature conditions at 40° F., 70° F., or 98° F. or at more than one of these temperatures to evaluate the effect of different storage temperatures on organoleptic quality. Frozen controls were held at 0° F.

A panel of ten or more experienced tasters graded unidentified irradiated samples and frozen or thermally sterilized controls for flavor characteristics at the American Can Company Laboratories at Maywood and Barrington.

The irradiated vegetables, with the exception of the green beans, were warmed to simulate normal serving conditions (the peas received a short cook to give a desirable texture). The frozen controls received sufficient cook to give a desirable texture.

The unpasteurized irradiated samples of ground beef and beef tenderloin as well as thermal controls were fried prior to tasting. Irradiated pasteurized ground beef and beef tenderloin were tasted fried and unfried.

The panel was asked to describe any off-flavor or odor and to score each sample for degree of off-flavor on a five-point scale.

(1) no off-flavor
(2) very slight off-flavor
(3) slight off-flavor
(4) moderate off-flavor
(5) bad off-flavor

Where statistical analysis revealed a significant difference between average scores of comparable variables a difference in flavor was judged to exist. Due to the almost universally adverse comments on the irradiated samples as compared to the thermal or frozen samples, these flavor differences are referred to as off-flavors throughout this paper.

The green bean taste tests were conducted at a later date using the nine-point hedonic scale *(7)*.

(1) like extremely
(2) like very much
(3) like moderately
(4) like slightly
(5) neither like nor dislike
(6) dislike slightly
(7) dislike moderately
(8) dislike very much
(9) dislike extremely

RESULTS AND DISCUSSION

The average taste test scores are presented in Tables 1-5.

Ground beef. The ground beef survived the irradiation with an attractive raw red color but with a noticeable off-flavor and odor, which was somewhat

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Mo., June 13, 1956.

TABLE 1
Average taste scores of irradiated ground beef

Storage temperature	Code	Free radical acceptor	Irradiation temperature	Thermal pasteurization	Treatment before tasting	Average Taste Test Scores						
						Initial	1 Month	2 Months	5 Months	9 Months	12 Months	24 Months
40°	1	1% Na Ascorbate	40-50	None	Fried	2.0			2.6		2.1	
	2A	1% Na Ascorbate	40-50	160°	Fried	1.3			2.9		2.7	
	2B	1% Na Ascorbate	40-50	160°	None				2.6			
	3	None	40-50	None	Fried	2.1			2.5		2.5	
	4	None	Frozen	None	None	1.6			2.4		3.0	
70°	1	1% Na Ascorbate	40-50	None	Fried			2.6	3.4	2.4	3.5	3.8
	2A	1% Na Ascorbate	40-50	160°	Fried			3.2	2.2	3.1	2.8	2.9
	2B	1% Na Ascorbate	40-50	160°	None			2.4	3.0	3.2		3.1
	3	None	40-50	None	Fried			2.8	3.3	3.6	3.3	2.8
	4	None	Frozen	None	Fried			2.6	3.1	3.4	2.7	3.2
98°	1	1% Na Ascorbate	40-50	None	Fried		3.4	2.9	3.2	3.5	3.6	
	2A	1% Na Ascorbate	40-50	160°	Fried		1.6	2.2	2.3	2.6	2.4	
	2B	1% Na Ascorbate	40-50	160°	None		2.3	3.7	3.3	3.4		
	3	None	40-50	None	Fried		2.0	2.4	2.6	3.3	3.6	
	4	None	Frozen	None	Fried		1.6	2.1	2.2	3.3	3.3	
70°	11	None	Thermal Process Control		None	1.3	1.6	1.7	1.0	2.0	1.0	1.4
0°	11A	None	Frozen Control		Fried					1.5		

reduced by irradiation in the frozen state, but which was not appreciably affected by pasteurization, by sodium ascorbate, or by frying.

After 9 months' storage the panel reported additional off-flavors described by some tasters as a "liver-flavor." In addition some liquid formation was noted after 9 months' storage at 70° or 98° F. Both the "liver-flavor" and liquid formation were reduced in ground beef pasteurized to 160° F. after irradiation suggesting enzymatic action as the source of these problems. The pasteurization, however, was accomplished at the expense of some of the attractive raw red color.

An unexpected phenomenon made its appearance after 9 months' of storage at 70° or 98° F. Unsightly, hard white particles, identified as tyrosine, appeared on the surface of the loaf. These were numerous and could only be removed with difficulty.

These particles appeared primarily on non-pasteurized samples and to a much lesser extent on "pasteurized" samples, but they were not observed on samples to which sodium ascorbate had been added until after 2 years at 98° F.

The ground beef was not readily made into patties for frying after 5 months' storage at 98° F.

The attractive color had faded some by the end of a year's storage at 98° F. or even 70° F.

TABLE 2
Average taste scores and pH of irradiated beef tenderloin

Code	Free radical acceptor	Irradiation temperature	Thermal pasteurization	Treatment before tasting	Average taste test scores						pH after twelve months		
					Initial	Two months at 40° F.	Nine months at 70° F.	Twelve months					
								40° F.	70° F.	98° F.	40° F.	70° F.	98° F.
5	1% Na Ascorbate	40-50° F.	None	Fried	2.0	3.1	3.4	3.5	2.8	3.4	6.10	6.13	6.50
6A	1% Na Ascorbate	40-50° F.	160° F.	Fried	2.4	2.9	3.4	2.8	3.4	2.7	6.00	6.04	6.11
6B	1% Na Ascorbate	40-50° F.	160° F.	None	2.2	3.0	2.7						
12	None	Thermal Process Control		None	1.1	1.6[1]	1.4		1.1			5.80	

[1] Stored at 70° F.

TABLE 3
Average taste scores of irradiated pork luncheon meat

Storage temperature	Code	Free radical acceptor	Irradiation temperature	Thermal pasteurization	Average taste test scores					
					Initial	1 Month	2 Months	5 Months	9 Months	12 Months
40° F.	7	1% Na Ascorbate	40-50° F.	160° F.	3.4			2.7		2.9
	8	None	40-50° F.	160° F.	4.1			2.7		3.0
	9	None	Frozen	160° F.	3.3			3.4		2.7
70° F.	7	1% Na Ascorbate	40-50° F.	160° F.			2.1	2.7	3.5	2.8
	8	None	40-50° F.	160° F.			2.9	2.5	3.2	2.3
	9	None	Frozen	160° F.			3.0	3.0	2.8	1.9
98° F.	7	1% Na Ascorbate	40-50° F.	160° F.		2.3	2.7	2.2	2.6	3.2
	8	None	40-50° F.	160° F.		3.0	2.7	2.3	2.7	3.0
	9	None	Frozen	160° F.		3.1	2.0	2.7	3.4	2.3
70° F.	13	None	Thermal Process Control		1.2	1.8	1.8	1.1	1.4	1.2

TABLE 4
Average taste scores of irradiated canned ham

Storage temperature	Code	Free radical acceptor	Irradiation temperature	Average taste test scores					
				Initial	1 Month	2 Months	5 Months	9 Months	12 Months
40° F.	10	1% Na Ascorbate	40-50° F.	3.0	—	—	2.9	—	2.4
70° F.	10	1% Na Ascorbate	40-50° F.		—	1.3	2.1	2.9	1.9
98° F.	10	1% Na Ascorbate	40-50° F.		2.9	2.0	2.3	3.1	3.0
70° F.	14	None	Thermal Process Control	1.2	1.4	2.0	1.5	1.3	1.4

All cans had become swells due to gas production by 3 years at 98° F. and were not tasted.

Beef tenderloin. Radiation and storage changes of beef tenderloin were essentially similar to those of ground beef, except that the white particles were not observed on samples which had been pasteurized even after 3 years at 98° F.

Pork luncheon meat. Pork luncheon meat received a pasteurization at 160° F. after irradiation. In addition to an off-flavor and -odor, the appearance of the irradiated samples was marred by separation of pinkish colored liquid fat from the loaf.

A brown discoloration appeared on the surface of the loaf after one month at 98° F. and after 2 months at 70° F. becoming more severe with continued storage. The thermal processed control was discolored to a lesser extent.

All samples were unattractive in appearance after 3 years' storage at 98° F. and they were not tasted.

Cured ham. The ham was found to have the least objectionable off-flavor of any of the meats as judged by the panel's scores. No change in flavor was detected on storage.

The appearance of the loaf was not much altered by irradiation, but the color faded on extended storage, finally becoming dark and easily broken up after 3 years' storage at 98° F.

Irradiated Vegetables

Asparagus. Although not as attractive as frozen controls, asparagus survived irradiation with a pleasing dark green color less faded than thermally processed asparagus and with a firmer texture. The panel noted an off-flavor in the irradiated samples, described by some as a loss of the characteristic asparagus flavor. A very faint off-odor was reported.

The color advantage of the irradiated asparagus over thermal processed asparagus proved short lived and after one month at 70° F. little difference was noted between the appearance of the irradiated spears and the thermal processed control. No change in flavor and odor was noted over 12 months' storage.

Effects of irradiation or storage were neither altered by blanch times up to 20 minutes at 200° F., by degree of vacuum in the can, by addition of 0.1% sodium ascorbate, nor by the absence of brine. An exception was

TABLE 5
Average taste test scores of irradiated vegetables

Vegetable	Code	Packing Procedure				Average taste test scores (1 = no off-flavor)						
		Blanch	Brine	Closure	Process	Initial	One Mo. at 70° F.	Three Mos. at 70° F.	Six Mos.		Twelve Mos.	
									40° F.	70° F.	40° F.	70° F.
Asparagus	0	0 Min.	Water	Exhaust	2.6M rep	2.6	3.1	2.2	3.2	3.1	3.0	—
	5	5 Min.	Water	Exhaust	2.6M rep	2.6	2.6	3.0	2.9	3.2	2.7	—
	10	10 Min.	Water	Exhaust	2.6M rep	2.3	2.3	3.7	3.2	2.9	3.2	—
	20	20 Min.	Water	Exhaust	2.6M rep	2.4	2.8	3.1	2.6	2.8	3.0	—
	10	10 Min.	Water	Exhaust	2.6M rep	3.1	3.0	2.5	2.8	2.8	2.5	—
	A	10 Min.	Ascorbate	Exhaust	2.6M rep	3.2	2.6	2.1	3.0	2.9	3.4	—
	V	10 Min.	Water	Vacuum	2.6M rep	2.7	2.9	2.3	2.8	3.0	3.1	—
	N	10 Min.	None	Vacuum	2.6M rep	2.2	2.7	2.2	3.0	2.9	2.6	—
	T	5 Min.	Water	Exhaust	Thermal	1.7	1.6	1.9	2.7	2.5	1.7	—
	F	5 Min.	None	Atmos.	Frozen[1]	1.2	1.2	1.6	1.9		3.1	
Broccoli	B	5 Min.	None	Vacuum	2.6M rep	3.3	—	3.4	3.4	3.0	—	—
	BT	5 Min.	Water	Exhaust	Thermal	2.3	—	4.1	—	—	—	—
	BF	5 Min.	None	Vacuum	Frozen[1]	1.0	—	1.3	1.3		—	
Brussels Sprouts	S	—	None	Vacuum	2.6M rep	4.0	—	4.2	—	2.6	—	4.0
	SF	—	None	Atmos.	Frozen[1]	1.0	—	1.2	1.2		1.6	
Cauliflower	C	5 Min.	None	Vacuum	2.6M rep	4.0	—	2.5	3.0	2.9	—	3.0
	CT	5 Min.	Water	Exhaust	Thermal	1.9	—	—	—	—	—	—
	CF	5 Min.	None	Atmos.	Frozen[1]	1.4	—	1.4	1.6		1.5	
Peas	P	3 Min.	None	Vacuum	2.6M rep	3.0	—	2.3	2.7	2.3	—	2.8
	PT	3 Min.	Water	Exhaust	Thermal	2.1	—	—	—	—	—	—
	PF	3 Min.	None	Atmos.	Frozen[1]	1.0	—	1.0	1.0		1.1	
						Average hedonic score (1 = like extremely)						
						9 Months at 70° F.			9 Months at 98° F.			
Green Beans	12+	3 Min.	Water	Steam Flow 3M rep		4.0			5.8			
	12−	3 Min.	None	Steam Flow 3M rep		7.7			7.9			
	T2	3 Min.	Water	Steam Flow Thermal		2.8			3.7			

[1] Stored at 0° F.

the asparagus packed with no brine which became seriously shrivelled.

Broccoli. The process of irradiation left the broccoli with an off-flavor and odor and a slightly darker color, which was actually not as dark as that of a thermally processed control. Texture of irradiated broccoli was firmer and less broken up than that of thermally processed broccoli.

In spite of a 5-minute blanch at 200° F., storage resulted in gradual darkening of the color until after 6 months the broccoli was an unsightly brown color.

Brussels sprouts. In addition to an off-flavor and off-odor irradiated brussels sprouts had lost their original bright green color to become brownish.

The brown color deepened on storage leaving a decidedly unappetizing vegetable by 3 months.

Cauliflower. The irradiated cauliflower acquired an off-flavor and off-odor as well as a slightly grayish cast compared to frozen controls. The florettes were moderately soft, but not as overcooked and mushy as thermally processed cauliflower. The color of the irradiated cauliflower was considered superior to that of the thermally processed sample which was more seriously darkened, but the panel considered the irradiated sample to have an off-flavor as compared to the flavor of the thermally processed sample.

Here, too, the irradiated vegetable darkened on storage in spite of a blanch of 5 minutes at 200° F. leaving the cauliflower an unattractive brown color after 3 months' storage. No thermally processed samples were available for storage comparisons.

Peas. The peas were judged by the panel to have a relatively slight off-flavor after irradiation. Off-odor was also slight and the color was a dark green considerably more attractive than the thermal control.

By 3 months, however, the color of the irradiated peas approximated that of the thermal processed peas.

The peas were not as much softened as other irradiated vegetables and required a cook to make them tender enough for serving.

Green beans. The panel as a whole showed a statistically significant preference for thermally processed beans as opposed to either irradiated variable although some tasters showed little or no preference. In addition, the panel preferred the sample irradiated with brine to that without brine.

The irradiated brine packed beans displayed an attractive green color superior to conventional canned beans but not as attractive as frozen beans at each examination. The green beans irradiated without brine, however, showed some darkening from the initial examination and formation of a jelly on the surface of the beans after 3 months' storage at 98° F. The irradiated beans were firm enough to sustain an addition cook before serving.

SUMMARY

Statistical analysis of taste test scores showed significant off-flover in each of the irradiated meats and vegetables in the experiment. In every case important changes in appearance or flavor developed on storage. Some of these changes, but by no means all, might be attributed to enzymatic action.

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Sodium Ascorbate in Stabilizing Cured Meat Color[a, b, c]

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USE OF ASCORBIC ACID AND SODIUM ASCORBATE to enhance the color characteristics of meat and meat products has been more prevalent since approval was granted in 1954 and 1955 *(6)*. Work by Chang and Watts *(3)* showed that color developed more rapidly in cured meat when ascorbic acid or its salt was used in conjunction with nitrite. Hollenbeck and Monahan *(5)* attributed the accelerated color fixation to the greater yield of nitric oxide when ascorbates were used in the cure. The nitric oxide united with myoglobin to form nitrosomyoglobin which is the more stable meat pigment.

Ascorbic acid was found by Watts and Lehmann *(8)* to protect cured meats from fading. Wilson, Weir, and Niven *(9)* found that regardless of the type of package, ascorbic acid extended the color life of bologna 37%, and sodium ascorbate 57% longer than the controls. Spraying the top bologna slice with a 6% solution of ascorbic acid also extended the color life. However, the addition of ascorbic acid to ground meat preserved by freezing resulted in a loss of surface color *(7)* Scarborough and Watts. Bauernfeind, Smith, and Siemers *(1)* reported that both the dip and spray methods of applying ascorbic acid to fish fillets were commercially practical for retarding oxidative rancidity.

Use of sodium ascorbate in the curing of hams, while desirable, has been handicapped by lack of a practical and economical means of introducing the ascorbate uniformly into the meat. The conventional brine pumping technique has not been satisfactory since neither ascorbic acid nor sodium ascorbate are completely stable when in solution with nitrite. Bauernfeind, Smith, and Parman *(2)* suggested the simultaneous incorporation of the curing salts and sodium ascorbate. The purpose of this investigation was, therefore, to evaluate the simultaneous injection method of incorporation of sodium nitrite and sodium ascorbate in ham curing.

METHODS AND MATERIALS

Experiments were carried out using 80 paired fresh hams showing some variation in marbling and muscle color. The additives used with the regular curing ingredients were ascorbic acid, sodium ascorbate, hexametaphosphate, tripolyphosphate, and monosodium glutamate.

In each experiment, the control hams (left) were artery pumped with a sterile 75° salinometer pickle made of a standard cure consisting of salt, cane sugar, and sodium nitrite. Nitrate was not used in any of the experiments. The pickle was injected into the hams equivalent to 10% of the green weight. A 65° salinometer cover pickle was used during the 3 days in cure. The hams were smoked and cooked to an internal temperature of 142° F. Center slices were removed from each ham for objective and subjective color measurements.

The right ham of each pair was processed in the same manner except for the addition of sodium ascorbate and the method of injecting the pickle. The pickle was injected simultaneously as two separate solutions, prepared from a sterile 75° salinometer stock solution. Equal quantities of the stock pickle were measured into two stainless steel beakers. Sodium ascorbate was dissolved in one solution at the rate of 4.26 g. per gallon which is equivalent to double strength for the quantity of brine. In the other solution, sodium nitrite was dissolved at the rate of 18.16 g. per gallon making it equivalent to double strength.

Both solutions were then poured into two separate 5-gallon stainless steel tanks joined at the top by a single pressure line. Outlets at the base of each tank were joined to form a single injection line. Solutions were simultaneously injected into the hams using 50 p.s.i.

Cured meat color was measured objectively with the Photovolt Reflectometer. In taking the reflectance measurements a 5 R 5/12 Munsell Color Chit was used as the reference standard. A constant voltage regulator was used to reduce line current fluctuation. The reflectometer was standardized before each reading with the amber, green and blue filters using 75, 39 and 17, respectively, as the reference points. Reflectance measurements of 5 muscles, *semitendinosus, biceps femoris, rectus femoris, adductor* and *semimembranosus* were used to calculate color brightness, and X and Y tristimulis values. These values were then used to plot dominant wave length and color purity from chromaticity charts. They were also used to calculate hue, value and chroma which are expressed as the Munsell Notation. Color measurements were taken on each slice just after the hams were cut and again after the slice had been prepackaged in 300 I.SAT cellophane. Daily readings over a 5-day period were taken. Ham slices were displayed at 38° F. under 60 foot candles of light with an air flow of 15 lineal feet per minute over the packages.

The myoglobin determinations were made on the component muscles from a 2-inch center section of the fresh ham. The *adductor, semimembranosus, biceps femoris* and *rectus femoris* were frozen, and ground twice through a fine plate to assure homogeneity. The procedure followed was that reported by Ginger, Wilson, and Schweigert *(4)*.

The *longissimus dorsi* muscle was removed from each of 3 pork carcasses and cut into 4-inch pieces. The sections from the left side of each carcass were cured in a regular 50° salinometer brine as the controls. Corresponding sections from the right side were cured in brine containing the various additives. Ascorbic acid and sodium ascorbate were used at the rate of 2.13 g. per gallon of brine. The polyphosphates were dissolved and mixed in the brine at the rate of 8 ounces per gallon. Monosodium glutamate was added equivalent to 3 ounces per 100 pounds of meat.

RESULTS AND DISCUSSION

Color of meat is difficult to express, since moisture, fat, and texture are considered to have a significant influence on the color characteristics. The data in Tables 1 and 2, indicate that dominant wave length is not an adequate means of expressing the hue of cured ham. Visual color description of the cured ham was not correlated with the hue as determined by dominant wave length. Hams cured with sodium ascorbate or ascorbic acid were found to have a lower dominant wave length

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and visually a darker red color than the controls. This would indicate that ascorbic acid, or its salt, in the presence of nitrite causes the myoglobin in the ham to develop a purple-red color.

TABLE 1

Color characteristics of cured ham muscles as influenced by display treatment [1]

Muscle	Before display [2]			Displayed 5 days		
	Dominant wave length	Purity	Brightness	Dominant wave length	Purity	Brightness
Semitendinosus	610	18	71.6	594	18	74.5
Biceps femoris	630	19	53.7	594	19	53.7
Rectus femoris	610	21	43.9	595	26	38.4
Adductor	602	19	53.0	601	15	49.5
Semimembranosus	599	17	70.0	592	18	65.1
Average	610	18	58.4	595	19.2	56.2

[1] Cured 3 days in a 65° pickle containing salt, sugar, sodium nitrite and sodium ascorbate. A 75° pickle was injected equivalent to 10% of the green weight.

[2] Prepackaged in 300 LSAT cellophane and displayed at 38° F. under 60 ft. candles of light.

TABLE 2

Color characteristics of cured ham [1] muscles as influenced by sodium ascorbate and display treatment

Muscle	Before display [2]			Displayed 5 days		
	Dominant wave length	Purity	Brightness	Dominant wave length	Purity	Brightness
Semitendinosus	494	13	64	595	23	59.8
Biceps femoris	494	18	52	584	26	44.0
Rectus femoris	495	22	38	596	22	35.2
Adductor	494	15	49	584	20	51.8
Semimembranosus	494	15	60	585	22	63.0
Average	494	16.6	52.6	588	22.7	50.8

[1] Cured 3 days in a 65° pickle containing salt, sugar, sodium nitrite and sodium ascorbate. A 75° pickle was simultaneously injected equivalent to 10% of the green weight.

[2] Center ham slices were prepackaged in 300 LSAT cellophane and displayed at 38° F. under 60 ft. candles of light.

A slight change was noted in the color purity of the regular cured ham; however, the hams cured with the ascorbates had more color strength. The *semitendinosus* and *semimembranosus* muscles were frequently found to have less color than other muscles of the ham. This accounts for the higher brightness factor found in each treatment.

The three dimensions of color—hue, value, and chroma—were found more nearly to express the observed color of cured ham than did dominant wave length. Effects of the display period and the use of sodium ascorbate in the brine on the color of cured ham are shown in Tables 3 and 4. The untreated cured ham, before being prepackaged and displayed, had an average hue value of 4.4R as compared to a value of 7.9R for the stored samples. The hue faded to a lighter shade of red during the 5-day storage period. The average hue value for the sodium ascorbate treated hams was 8.5RP, indicating the color was a deeper red-purple than the ham cured without sodium ascorbate. Visually, the color was a deep red and appeared to have more strength than the control. The display life of this product was increased by 50%. The hue for each ham muscle cured with sodium ascorbate was found to have a slightly more uniform color, but this color did not remain uniform throughout the prepackaged display period of 5 days.

The value (light) in the cured meat color remained nearly the same regardless of the display treatment. The average chroma or color strength decreased during the display period by a value of 1.4 (Table 3). The sodium ascorbate treated ham also decreased in color strength by 2.2, but the initial color was darker and remained more acceptable than the control during the 5-day display period.

The variation in myoglobin content for individual ham muscles is given in Table 5. Consistently, the *semitendinosus* muscle had the least amount of myoglobin, while the *rectus femoris* was found to have the greatest amount. The variation in myoglobin content was considered to be partially responsible for the lack of color uniformity. The most striking color deficiency was in the *semitendinosus* muscle. This was considered to be due to the lack of myoglobin and/or the migration of cure into this muscle.

TABLE 3

Munsell color notation of cured ham muscles as influenced by display treatment [1]

Muscle	Before display [2]		Displayed 5 days	
	Hue, value, chroma		Hue, value, chroma	
Semitendinosus	4.8R	8.7/6.0	9.0R	8.8/4.2
Biceps femoris	5.0R	7.7/7.6	8.5R	7.7/4.5
Rectus femoris	1.6R	7.0/6.0	8.0R	6.0/6.0
Adductor	4.3R	7.6/5.6	5.5R	7.5/4.3
Semimembranosus	6.4R	8.6/4.8	8.4R	8.3/4.0
Average	4.4R	7.9/6.0	7.9R	7.6/4.6

[1] Cured 3 days in a 65° pickle. Ham pumped equivalent to 10% of the green weight with a 75° pickle.

[2] Center slices were prepackaged in 300 LSAT cellophane and displayed at 38° F. under 60 ft. candles of light.

TABLE 4

Munsell color notation of cured ham [1] muscles as influenced by sodium ascorbate and display treatment

Muscle	Before display [2]		Displayed 5 days	
	Hue, value, chroma		Hue, value, chroma	
Semitendinosus	8.0RP	8.3/6.7	8.7R	8.0/5.6
Biceps femoris	8.5RP	7.6/8.2	6.5R	7.1/3.5
Rectus femoris	7.5RP	6.7/8.6	8.0R	6.4/4.7
Adductor	8.9RP	7.4/6.9	6.4YR	7.6/3.0
Semimembranosus	8.7RP	8.1/7.5	5.0R	8.2/3.8
Average	8.5RP	7.6/7.6	7.0R	7.4/5.4

[1] Cured 3 days in a 65° pickle containing salt, sugar, sodium nitrite and ascorbic acid. A 75° pickle was simultaneously injected equivalent to 10% of the green light.

[2] Center ham slices were prepackaged in 300 LSAT cellophane and displayed at 38° F. under 60 ft. candles of light.

TABLE 5

Myoglobin content of fresh ham muscles [1]

	Range [2]	Average
Adductor	0.56 — 0.68	0.66
Semitendinosus	0.49 — 0.70	0.61
Biceps femoris	0.60 — 0.76	0.69
Rectus femoris	0.92 — 1.32	1.09

[1] Values expressed as mg. of myoglobin per gram of fresh tissue.

[2] Data on 10 hams showing visual color differences.

Data in Table 6 show the effect of the prepackaged display period on the color stability of ham cured with sodium ascorbate in the brine. The control hams had a light gray-pink color which faded during the first 12 hours of display. The hams cured with sodium ascorbate faded more slowly and were considered by a panel to be salable after 24 hours of display storage.

The changes in hue, value, and chroma for hams cured with different additives in the brine are shown in Table 7. Hams cured in brine containing ascorbic acid were found to have a deeper red color and the color did not fade as rapidly during the display period as the control. Sodium ascorbate was equally as effective in obtaining the desired initial color, but fading was slightly more rapid during the display storage period. Hams cured in brine containing both ascorbate acid and sodium hexametaphosphate were found to have a color equal to that cured in brine containing only the ascorbic acid.

TABLE 6
Effect of display period on the color stability of cured ham [1]

Display period days	Control color [2]		Treated [2] color	
	Hue, value, chroma		Hue, value, chroma	
0	6.4R	5.2/4.3	5.3R	5.5/3.6
2	2.2YR	5.1/3.1	8.7R	5.4/3.2
3	6.5YR	5.3/2.7	4.4YR	5.2/2.0
7	7.8YR	5.1/2.8	6.4YR	5.2/4.2

[1] Cured 3 days in a 65° pickle consisting of salt, sugar, and sodium nitrite. A 75° pickle was simultaneously injected equivalent to 10% of the green weight.
[2] Ascorbic acid was used in the cure at the rate of 2.13 g. per gallon.
[3] Values are an average of 5 muscles on center slices from 20 hams.

The data in Table 8 show that various polyphosphates have an influence on the color of the cured *longissimus dorsi* muscle. Pork muscle cured in brine containing sodium ascorbate plus sodium hexametaphosphate had a more desirable color than muscle cured in brine containing sodium ascorbate plus sodium tripolyphosphate. Monosodium glutamate, in conjunction with sodium ascorbate, was found to aid in fixing a desirable color. Visually, the color of this cured muscle was a light gray-pink being more characteristic of cured ham than samples cured with either ascorbic acid or sodium ascorbate.

TABLE 7
Color dimensions of cured ham [1] as influenced by various chemical additives and display treatment

Treatment	Color [2] Before display		Color After display [3]	
	Hue, value, chroma		Hue, value, chroma	
Control	5.0R	5.7/5.3	3.4YR	5.8/2.9
Ascorbic Acid	5.3R	5.7/4.3	1.1YR	5.7/2.3
Sodium Ascorbate	5.7R	5.9/3.9	2.4YR	5.9/2.5
Ascorbic Acid + Sodium Hexametaphosphate	5.5R	5.8/4.8	1.3YR	6.2/2.5

[1] Cured 3 days in a 65° pickle consisting of salt, sugar, and sodium nitrite. A 75° pickle was simultaneously injected equivalent to 10% of the green weight.
[2] Average of 5 muscles on center slices from 20 hams.
[3] Prepackaged and displayed under 60 ft. candles of light for 5 days.

SUMMARY

Simultaneous injection of two brine solutions, one containing sodium ascorbate or ascorbic acid, and the other sodium nitrite is shown to be an effective method for introducing the two chemicals into ham.

Evidence is presented to further substantiate the value of using ascorbic acid and sodium ascorbate in the curing process. Cured meat color was determined for individual ham muscles and reported in terms of Munsell Notation for hue, value and chroma.

Hams cured in a brine containing ascorbic acid were found to have a deeper red color than the controls. The color of the cured center ham slice did not fade as rapidly during the 5-day display storage period as that of the regular cured ham. Sodium ascorbate was equally as effective in obtaining the desired initial color, but fading was slightly more rapid during display storage. Hams cured in brine containing both ascorbic acid and sodium hexametaphosphate were found to have a red color equal to those hams cured in brine containing only the ascorbic acid.

The *longissimus dorsi* cured in brine, containing sodium ascorbate plus sodium hexametajhosphate, had a more desirable color than muscle cured in brine containing sodium ascorbate plus sodium tripolyphosphate.

Pork muscle cured in brine containing monosodium glutamate in conjunction with sodium ascorbate was found to have a light gray-pink color which was considered to be more characteristic of cured ham than those samples cured with either ascorbic acid or sodium ascorbate.

TABLE 8
Color dimensions of cured longissimus dorsi muscle as influenced by chemical additives and display treatment [1]

Treatment	Display [2] period days	Color [3]	
		Hue, value, chroma	
Sodium Ascorbate + Sodium Hexametaphosphate	0	5.3R	5.1/5.4
	3	5.4R	5.0/4.7
	6	8.3R	5.0/4.8
	9	7.3R	4.8/5.0
Sodium Ascorbate + Sodium Tripolyphosphate	0	9.4R	4.6/4.1
	3	5.0YR	4.0/3.6
	6	8.5YR	4.1/3.3
	9	5.8YR	3.8/3.4
Sodium Ascorbate + Monosodium Glutamate	0	3.8R	4.5/6.3
	3	4.6R	4.3/4.6
	6	6.9R	4.2/4.8
	9	1.0YR	4.1/4.4
AscorbicAcid + Sodium Tripolyphosphate	0	6.1R	4.9/5.9
	3	2.1YR	4.4/4.2
	6	4.2YR	4.1/4.0
	9	7.2YR	3.9/3.4
Control	0	4.6R	4.8/5.7
	3	6.0R	4.6/4.1
	6	7.9YR	4.4/4.0
	9	9.2YR	4.2/4.3

[1] Sections of *longissimus dorsi* muscle were cured in a 65° pickle containing the various chemicals.
[2] Slices were cut ½ inch thick, prepackaged in 300 LSAT cellophane, and displayed under 60 ft. candles of light.
[3] Average reading for 3 separate trials, using the *longissimus dorsi* from 3 carcasses.

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On the Color of Coffee[a]

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Expert coffee tasters have established standards based on color for the roasting of green coffee, by means of which the roaster operator can determine when the roast for the current blend is "finished." These standards are set by individual judgment, and do not as yet provide a basis for industry-wide standards. Attempts have been made in industry, by application of colorimetric techniques, to provide a closer control of the roasting procedure. Ultimate objective of the present investigation is to provide a simple, accurate method which can be applied to routine industrial control.

The characteristics of brewed coffee are affected by many factors. In this paper, we discuss the color of the ground roasted coffee bean, as affected by origin, roasting temperature and degree of grind, on samples of commercial origin. A limited number of samples[b] were examined for possible effects of harvest maturity and drying conditions. The color of the finished roast has also been considered in relation to the color of a standardized brew, and to changes in ultraviolet-absorbing components of the brew.

MATERIALS AND METHODS

Coffee samples. The origins of the coffee samples used here are as follows:

1. Unblended, prepared for the Coffee Brewing Institute, under experimental roasting conditions, from Santos, Maracaibo, Medellin, Colombia (past crop), Bucaramanga (old crop), and Central America. Samples of whole beans roasted at different temperatures were sent to us under the above designations.

2. Blended, commercially roasted, unground, by a San Francisco coffee manufacturer, designated light, medium, high and French roasts.

3. Brazilian samples, finished roast, ripe Bourbon vermilion, dried at different temperatures, and Bourbon vermilion harvested at various stages of maturity but dried at constant temperature.

Grinding of samples. All samples were ground in a commercial coffee grinder (Hobart Manufacturing Company) to the desired degree of fineness.

Particle size distribution. The sieving procedure proposed by the National Coffee Association was followed *(3)*. This involved placing 100 g. of ground coffee on the top sieve of a nest of 10-, 14-, 20-, and 28-mesh W. S. Tyler Company standard wire screen sieves and agitating for 5 minutes on a W. S. Tyler Ro-Tap Sieve Shaker.

Measurement of the color of ground coffee. Measurements were made on a Colormaster Differential Colorimeter (Manufacturers Engineering and Equipment Corporation). Reflectance readings of a sample of ground coffee placed in a clean glass cell were made with the 3 filters, green, red and blue in succession. For the 300° and 325° F. roasts, readings were made against a standard white plaque. All other samples were read against a 20% reflectance neutral gray plaque set at 100%. The true reflectance values were calculated by use of the proper conversion factors. At least 5 series of readings were made for each sample and the averages determined.

Preparation of aqueous extracts. Five grams of ground coffee were placed in a jacketed glass column fitted with a medium porosity sintered glass disc. Water at 60° C. was circulated through the jacket to insure constant temperature of extraction, and 50 ml. of water heated to 100° C. was poured over the sample of coffee and left in contact with it for 2 minutes. The aqueous extract was collected, the rate of outflow being so regulated that elution was completed in 2 minutes. After cooling the extract, the volume of the eluate was adjusted to 100 ml. Each sample was run in duplicate.

Measurement of the color of the aqueous extracts. A model DU Beckman Quartz Spectrophotometer was used to measure the percent transmittance of the samples from 400-700 mμ at 10 mμ intervals. C. I. E. tristimulus values and trichromatic coefficients were calculated from the data by the Weighted Ordinate Method, Hardy *(1)*.

Measurement of the ultraviolet-absorbing components. The ultraviolet absorption spectra were determined on 1-200 dilutions of the above extracts for the range 220 to 360 mμ.

RESULTS AND DISCUSSION

Effect of particle size. When samples of coffee were ground in a commercial coffee grinder to coarse, medium (percolator) and fine (vacuum pot) specifications, variability in the lightness or Y values of a given roast was noted, with the coarser grinds tending to have higher reflectance values. When the samples were separated into fractions of more uniform particle size by sieving, it was found that for a given roast, the Y value for the fraction which passed through the control or 28-mesh screen was invariably higher than that of any other fraction. These data are summarized in Table 1. It will be seen that particle size has little effect on the Y value over the range 0.6 to 1.8 mm., and the

TABLE 1
Variation in Y value with particle size

	Y Percent				
	Fraction 1 >1.680 mm.	Fraction 2 1.168-1.680 mm.	Fraction 3 0.833-1.168 mm.	Fraction 4 0.589-0.833 mm.	Fraction 5 <0.589 mm.
Light Roast	4.8	5.0	4.7	5.4	7.2
Medium Roast	4.5	4.2	4.3	4.8	6.0
High Roast	4.0	4.1	4.2	4.7	5.8
French Roast	3.1	2.8	2.9	3.2	3.3

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, June 12, 1956, St. Louis, Missouri.

[b] Provided through the courtesy of our colleague, Mr. Sherman Leonard.

French roast is the most uniform. The dust <0.6 mm. increases the apparent lightness significantly for all except the highest roast.

The Y values and the levels of ultraviolet-absorbing components of the aqueous extracts of the above samples clearly indicated that a higher extraction of colored and colorless components was obtained with the more finely ground samples. Tables 2 and 3 demonstrate the effect of grind on the water-extracted components. The Y value of the coffee extract is significantly affected by the degree of grind, but not by the roast except for the French which was consistently lower. The concentrations of the ultraviolet-absorbing components fell with increasing roasting temperature, but rose with increasing grind. The fall is presumably due to destruction with increasing severity of the roast. The rise may be attributed to increased efficency of extraction.

TABLE 2
Aqueous extracts of coffee. Effect of grind on Y value

	Y Percent		
	Fine grind	Medium grind	Coarse grind
Light Roast	43.0	44.7	53.5
Medium Roast	41.7	44.2	54.5
High Roast	42.0	43.5	52.7
French Roast	33.5	37.2	42.2

As it was apparent that the particle size distribution had a significant effect on the determination of color in the roasted ground coffee as well as on the extractibility of water-soluble components, conditions were then standardized to the vacuum pot or very fine grind. Although this did not insure identical particle size distribution, it did minimize these effects.

Color development during the roasting cycle. Reflectance characteristics were determined for the samples designated Santos, Maracaibo, Medillin, Colombian (past crop), Bucaramanga (old crop) and Central America respectively roasted at 300, 325, 350, 375 and 400° F. (or 390° F.) and the "finished roast." In Table 4 are listed the average Y values. The maximum standard deviation was ±5% of the mean. It will be noted that from the 300° F. to the 350° F. roast, there is approximately a 50% drop in the Y value for all samples except the Bucaramanga, while the drop in Y between 350° F and 400° F. averages around 60%. The Y value of the Bucaramanga sample decreases at a slower rate than do those from the other sources, and although an explanation for this is not immediately apparent, it is of interest that the "initial" of 300° F. roast Y value is significantly and markedly lower than the "initial" Y values of the other samples.

In Table 5 is shown the percentage decrease in Y with increased temperature of roast. From the data summarized in Table 5, the curves shown in Figure 1 were constructed.

TABLE 5
Percentage decrease in Y value with increasing temperature of roast

Source	$\frac{Y_{350}}{Y_{300}} \times 100$	$\frac{Y_{400}}{Y_{300}} \times 100$	$\frac{Y_{finished}}{Y_{300}} \times 100$
Santos	52.0	—	26.6
Maracaibo	50.6	21.0	19.1
Medellin	46.5	19.0	17.2
Colombia (past crop)	51.5	18.0	16.3
Bucaramanga (old crop)	59.7	26.7	24.0
Central America	51.5	—	25.3
Average	$\frac{Y_{350}}{Y_{300}} \times 100$		$\frac{Y_{400}}{Y_{300}} \times 100$
(1) Including Bucaramanga	53.6 ($\sigma = \pm 5.6$)		21.2 ($\sigma = \pm 4.0$)
(2) Excluding Bucaramanga	50.4 ($\sigma = \pm 2.0$)		19.3 ($\sigma = \pm 1.5$)

If we assume that the lowest curve (a) in Figure 1 represents the situation for those samples whose "initial" Y values are relatively high (i.e. approximating those of all the samples included in this study except for Bucaramanga) we should be able to predict the Y value of an unknown sample roasted at a given temperature, or alternatively, predict the roasting temperature necessary to give a desired color.

In Table 6 are listed the calculated and experimentally determined Y values for the samples from the 6 locales under investigation at various temperatures of roast.

Correction factors used in predicting the decrease in Y with increasing temperature of roast for the Bucara-

TABLE 3
Aqueous extracts of coffee. Effect of grind on U-V-absorbing components

	Fine	D_{265} Medium	Coarse	Fine	D_{320} Medium	Coarse	Fine	D_{265}/D_{320} Medium	Coarse
Light Roast	.410	.359	.269	.399	.341	.252	1.02	1.05	1.07
Medium Roast	.362	.314	.259	.339	.288	.230	1.07	1.09	1.12
High Roast	.334	.302	.208	.306	.276	.187	1.09	1.09	1.28
French Roast	.262	.229	.194	.218	.185	.151	1.20	1.24	1.28

TABLE 4
Variation in Y value with source and degree of roast

Source	Y Values (%)					
	300° F.	325° F.	350° F.	375° F.	400° F.	"Finished roast"
Santos	25.9	19.7	13.5	8.2	—	6.9 (381° F.)
Maracaibo	26.7	20.3	13.5	8.0	5.6	5.1 (401° F.)
Medellin	25.6	18.9	11.9	7.5	4.9	4.4 (405° F.)
Colombia (past crop)	28.2	19.9	14.5	8.3	5.1	4.6 (406° F.)
Bucaramanga (old crop)	19.1	16.0	11.4	7.7	5.1	4.6 (411° F.)
Central America	23.7	16.9	12.2	7.4	6.0 (390° F.)	6.0 (391° F.)

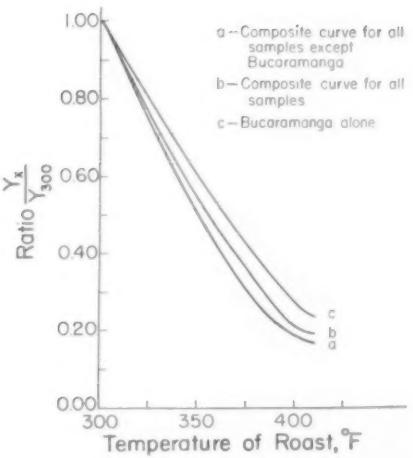

Figure 1. Decrease in Y value with increasing temperature.

manga samples were calculated from the curve obtained for this variety compared with the composite curve obtained for the five other varieties. For the Bucaramanga, the ratio $\frac{Y_{350}}{Y_{300}}$ was 0.60, and the ratio $\frac{Y_{400}}{Y_{300}}$ was 0.27, compared with 0.50 and 0.19, respectively, for the composite curve. Thus, the factors 1.2 and 1.4 were needed to correct the predicted Y values for the 350 and 400° F. roasts respectively for the Bucaramanga samples. The correction factors at 325 and 375° F. and "finished roast" were estimated to be 1.1, 1.3 and 1.4, respectively, by interpolation.

Results of this investigation indicate that the rates of decrease in Y for 5 of the 6 series of samples from various sources are essentially identical, and that from the rate curve obtained, we may predict the Y value of a given sample at any given temperature of roast with a high degree of accuracy, provided the "initial" Y has been determined. The anomalous results obtained with the Bucaramanga samples suggests that there may exist a family of curves to describe the rate of change of Y with increasing temperature, depending on the "initial" Y. However, a second possibility is that the description "old crop" for the Bucaramanga may merely indicate that the beans had darkened on prolonged storage and had in effect already undergone color changes similar to those occurring during the early stages of the roasting cycle, with a resulting apparent decrease in rate of change of Y.

Color of aqueous extracts. C.I.E. tristimulus values and trichromatic coefficients for the extracts from the various samples were calculated from transmittance measurements over the range 700 to 400 mμ. It was observed that the Y value decreased with increase in roasting temperature for the range 390 to 411° F. This was not the case for samples roasted at 375° F. or below, owing to a marked increase in turbidity of these extracts.

Ultraviolet-absorption spectra. The ultraviolet absorption of aqueous extracts of roasted coffee shows two broad absorption bands with maxima *ca* 285 mμ and *ca* 320 mμ. Compounds such as caffeine and furfural have absorption maxima in the 275-285 mμ range, while chlorogenic acid is reported to have a maximum at 323 mμ. [Proctor and Goldblith *(2)*].

In Figure 2 the change in relative intensities of the two peaks with increasing temperature of roast is shown

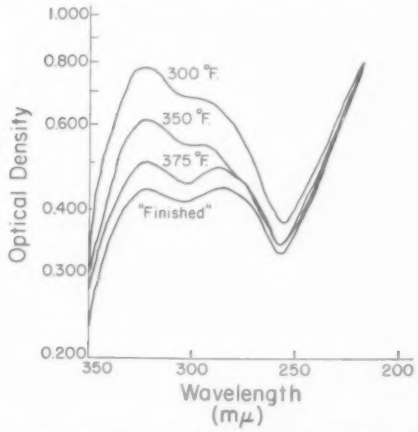

Figure 2. Aqueous extracts of Santos samples. Effect of roasting temperature on ultraviolet-absorbing components.

for the Santos bean. Results from the other samples are similar. Further, the relative heights of the two maxima show a marked difference with increasing roasting temperature, the rate of disappearance of the component absorbing at 320 mμ is considerably faster than that of the material absorbing around 285 mμ. It reflects the breakdown of chlorogenic acid with increasing temperature.

TABLE 6
Comparison of predicted and experimentally determined Y values

Variety	Y 300° F. Exper.	Y 325° F.		Y 350° F.		Y 375° F.		Y 400° F.		Y "Finished"	
		Exper.	Calc.	Exper.	Calc.	Exper.	Calc.	Exper.	Calc.	Exper.	Calc.
Santos	25.9	19.7	18.8	13.5	13.0	8.2	7.8	....	5.0	6.9 (381° F.)	7.0
Maracaibo	26.7	20.3	19.4	13.5	13.4	8.0	8.0	5.6	5.1	5.1 (401° F.)	5.1
Medellin	25.6	18.9	18.5	11.9	12.8	7.5	7.7	4.9	4.9	4.4 (405° F.)	4.4
Colombia (past crop)	28.2	19.9	20.4	14.5	14.1	8.3	8.5	5.1	5.3	4.6 (406° F.)	4.8
Bucaramanga (old crop)	19.1	16.0	15.2[1]	11.4	11.5[1]	7.7	7.4[1]	5.1	5.1[1]	4.6 (411° F.)	4.5[1]
Central America	23.7	16.9	17.2	12.2	11.9	7.4	7.1	....	4.5	6.0 (391° F.)	5.2

[1] Results calculated by use of correction factors determined experimentally.

In Table 7 are listed the average optical density readings at 285 mμ and 320 mμ and the ratios $\frac{D_{285}}{D_{320}}$ for the samples from all sources roasted at a given temperature. Standard deviation for the optical density readings at a given temperature was as high as ±16% of the mean. Furthermore, readings of duplicate samples frequently agreed to a lesser extent than did readings of two samples from different sources. This indicates that under normal brewing conditions, the extracts of coffee beans from different sources show no significant differences in the levels of ultraviolet-absorbing components.

TABLE 7
Variation in ultraviolet-absorption with temperature of roast

Temperature of roast ° F.	D_{285}	D_{320}	$\frac{D_{285}}{D_{320}}$
300	0.610	0.753	0.81
325	0.662	0.776	0.85
350	0.594	0.662	0.90
375	0.466	0.464	1.00
381	0.415	0.412	1.00
390	0.335	0.310	1.08
391	0.358	0.326	1.10
400	0.262	0.231	1.13
401	0.289	0.252	1.14
405	0.269	0.233	1.15
406	0.264	0.218	1.21
411	0.236	0.186	1.27

The apparently lower readings for the samples roasted at 300° F. probably may be explained on a physical basis. These were less friable, more moist and therefore could not be ground as finely as those roasted at the higher temperatures. It had previously been established that the finer the grind, the more efficient the extraction of the ultraviolet-absorbing components. Because of the relative coarseness of the samples roasted at low temperatures, the results were significantly lower. Since samples roasted at these temperatures are commercially unimportant, no effort was made to correct the discrepancies.

We then examined the color of ground roasted coffee as expressed by the Y value in relation to concentration of the ultraviolet-absorbing components to be found in a brew prepared under standardized conditions, as expressed by D_{285}, D_{320} and $\frac{D_{285}}{D_{320}}$ of diluted solutions of aqueous extracts. These results are summarized in Table 8. Samples 1-4 were the blended, commercially prepared light, medium, high and French roasts, respectively. Samples 5-8 were the roasted Bourbon vermilion cherries dried at 35, 45, 55 and 70° C., respectively. Samples 9-12 were roasted Bourbon vermilion beans dried at 45° C., but harvested at "em coco," "passa," "cereja" and overripe stages of maturity respectively.

As the "initial" Y values were not known for these samples, the probable temperatures of roast were estimated from the average Y values at a given temperature of the samples from all sources except Bucaramanga described above. Similarly, the probable temperatures of roast were determined from Table 7 on the basis of ultraviolet-absorption. From Table 8 it will be noted that the probable temperatures of roast determined by the two methods were in close agreement. A high degree of correlation therefore exists between the color of the roasted ground bean and the level of the ultraviolet-absorbing components regardless of origin or previous treatment of the beans. It is tentatively concluded that determination of tristimulus Y for the roasted ground coffee defines both the roasting conditions of the bean and those physical properties of the brew which are related to color.

TABLE 8
Relationship of color of ground roasted coffee to ultraviolet-absorption of aqueous extracts

Sample No.	Y	Probable temperature of roast ° F.	D_{285}	D_{320}	$\frac{D_{285}}{D_{320}}$	Probable temperature of roast ° F.
1	6.9	386	.410	.399	1.03	382
2	6.0	393	.362	.339	1.07	389
3	5.5	396	.334	.306	1.09	393
4	3.4	407	.262	.218	1.20	408
5	8.0	381	.462	.470	0.98	375
6	7.1	386	.335	.338	0.99	387
7	9.4	373	.440	.458	0.96	373
8	8.2	380	.361	.365	0.97	382
9	7.5	384	.316	.310	1.02	390
10	8.0	381	.460	.464	0.99	375
11	10.1	368	.395	.422	0.84	370
12	13.2	349	.610	.680	0.89	347

SUMMARY

A relationship has been established between roasting temperature and (a) the color of roasted ground coffee, (b) the relative concentrations of ultraviolet-absorbing components in the aqueous extracts prepared under standardized conditions, and (c) the color of the aqueous extracts. In the last case, however, the relationship exists only for roasting temperatures within the commercial range, i.e. 380-410° F. A method is suggested for predicting the roasting conditions necessary for the development of a desired color in a given sample, or, conversely, for predicting the color of a sample roasted at a given temperature.

Acknowledgment

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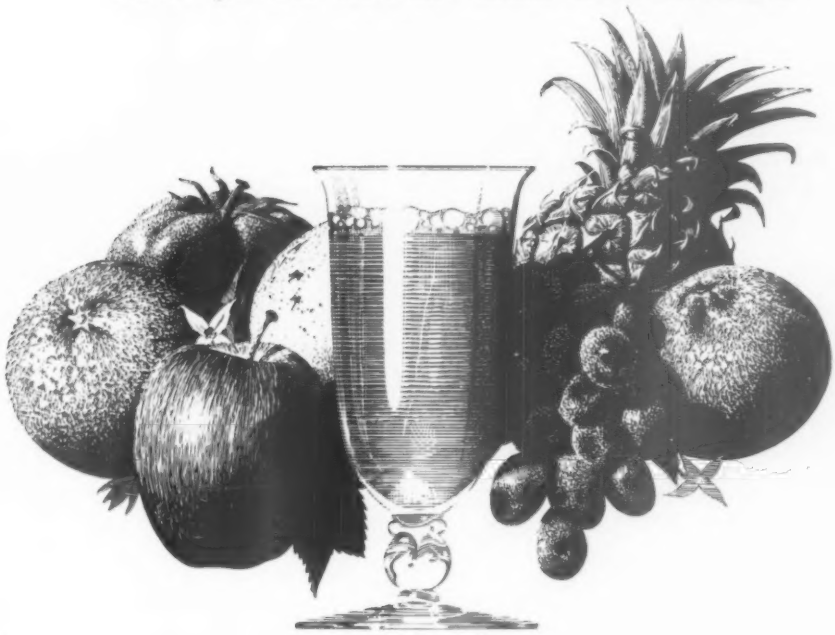

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	Min.	Max.
Grapefruit juice	10.0	49.0
Orange juice	9.7	70.0
Pineapple juice	5.4	18.0
Apple juice	0.2	3.6
Grape juice	0.0	4.7
Tomato juice	2.5	32.0

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SELECTED ABSTRACTS . . .

Compiled by H. A. Campbell

ANALYTICAL METHODS

An improved boric ester method for the isolation of alcohols.

Owen, W. R., and Sutherland, M. D. (Univ. of Queensland, Brisbane, Australia). *J. Sci. Food Agr., 7* (1), 88-92 (1956).

In an improved process for the sepn. of alcs. and phenols as borate esters from other volatile substances, transesterification with Bu borate is carried out in a solvent such as methyl*cyclo*hexane which forms an azeotrope with Bu alc. The boratization of sol. hydroxylic compds. proceeds quickly to an easily recognized completion. The application of the new procedure to the isolation of geijerene from the essential oil of *Geijera parviflora* Lindley is described.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

The specificity of pancreatic lipase for the primary hydroxyl groups of glycerides.

Mattson, F. H., and Beck, L. W. (The Procter and Gamble Co., Cincinnati, Ohio). *J. Biol. Chem., 219,* 735-40 (1956).

Various defined triglycerides were subjected to hydrolysis by pancreatic trypsin and the digestion products isolated and characterized. Hydrolysis is shown to be a stepwise series of reactions from triglyceride to 1, 2 diglyceride to 2-monoglyceride. These steps occurred regardless of the position of the individual fatty acids considered and in a random manner. Pancreatic lipase is therefore specific for the hydrolysis of long chain fatty acids esterified with primary hydroxyl groups of glycerol.

Starch degradation by salivary amylase. III. Residual dextrins and the glucose formation.

Myrback, K., and Willstaedt, E. (Univ. Stockholm). *Arkiv. Kemi, 7* (5); 403-15 (1954); *Biol. Abstr., 30* (2), No. 4022 (1956).

Residual dextrins produced from starch by salivary amylase were isolated and roughly fractionated. Chromatographical examn. showed that the fractions contained dextrins with 4-7 glucose units, some still higher. In all expts. a very slow hydrolysis of residual dextrins with 6 or more units took place, probably also a hydrolysis of pentasaccharides. Glucose was liberated and, also to some extent, maltose. No isomaltose was formed and little or no trisaccharide. The tetrasaccharide residual dextrin fraction, on the other hand, increased strongly, and the amts. of higher residual dextrins, especially those with 6 and 7 glucose units, decreased. Rapid hydrolysis of starch (amylopectin) by salivary amylase yielded residual dextrins with 4-8 units. Certain samples of human saliva, and partially heat-inactivated solns. of saliva had a weak but distinct action on maltose. Glucose was also formed from higher saccharides, presumably from the reducing end of the chain. This reaction, which is probably characteristic of the pure amylase, was also involved in the slow secondary saccharification of the "primary" residual dextrins.

Vitamin B_6 and protein synthesis.

Lichstein, H. C. (Univ. Minnesota, Minneapolis). *J. Biol. Chem., 219,* 27-9 (1956).

Data are presented which demonstrate that the synthesis of the enzyme tryptophanase by a strain of *Escherichia coli* is dependent on the presence of vitamin B_6, thus furnishing more direct evidence for the role of this vitamin in protein synthesis.

Bouillon aroma of protein hydrolyzate.

Brockmann, H., and Franck, B. (Org.-Chem. Inst., Univ. Göttingen, Ger.). *Angew. Chem., 67,* 303 (1955); *Z. Lebensm. Untersuch. u-Forsch., 103* (6), 457 (1956).

Synthetic α-keto-butyric acid shows an unusually intense and lasting bouillon aroma. The aroma of protein hydrolyzates, peviously attributed to threonine, is due to this compd. formed from threonine.

Reactions between amino-acids, organic acids and sugars in freeze-dried apricots.

Anet, E. F. L. J., and Reynolds, T. M. (Commonwealth Sci. and Ind. Res. Organization, Homebush, New South Wales). *Nature, 177,* 1082-3 (1956).

After sepn. of an apricot concentrate (30% solids) into cationic, anionic and neutral fractions, browning could be demonstrated by combining any two fractions and storing them at 57° C. The reactions of these materials were studied in freeze-dried apricot puree stored at 25° C. (70% rel. humidity) for 16 months (79% solids). The loss of free amino acids, malic and citric acids could be accounted for by the production of 1-deoxy-1-(N-amino-acid)-fructoses and traces of 2-deoxy-2-(N-amino-acid)-glucoses, plus sucrose, glucose and traces of fructose half-esters of malic and citric acids. There was also a loss of significant amts. of glucose and fructose. It was concluded that at this relatively early stage of browning the colored compds. were formed from sugars without the incorporation of any significant amt. of amino acid or org. acid residues.

Detoxification of cottonseed meals.

Delvaux, E. L. (Korbeek-Lo/Belgien). *Fette, Seifen Anstrichmittel, 58* (5), 347-53 (1956).

Technical processes which include treatment with humid heat detoxicate cottonseed meals but influence the digestibility of the proteins unfavorably. Polar solvents are promising, but expensive. Chances for use of cottonseed meal for human consumption are small.

MICROBIOLOGY

Alterations in the nitrogen excretion pattern of chicks infected with Salmonella pullorum.

Ross, R. T., Holtman, D. F., and Gilfillan, R. F. (Univ. of Tennessee, Knoxville). *J. Bacteriol., 71* (5), 521-4 (1956).

Investigations concerning the host-parasite relationship which exists in chicks infected with *Salmonella pul-*2—Food Tech—Oct.—9766—Abstracts jp *lorum* have revealed that the pattern of N excretion normally present in this bird is altered during the course of infection. Blood urea is increased 7- to 10-fold and represents the principal form of amino N in the circulatory system of the infected chick. This urea presumably is of arginolytic origin and is formed via the ornithine-citrulline cycle. Arginase activity, which is present in minute quantities or absent altogether in normal chicks, is increased within 24 hr. following infection. The protective action of arginine previously reported has been attributed to its role in synthesis of urea which is inhibitory to the growth of *S. pullorum.*

Individual constancy of numbers among the oral flora.

Kraus, F. W., and Gaston, C. (Univ. of Alabama Med. Center, Birmingham). *J. Bacteriol., 71* (6), 703-7 (1956).

The tendency toward higher or lower counts of aerobic organisms in unstimulated saliva appears to be an individual characteristic. The same holds true for certain genera of these bacteria, such as the streptococci, and again also for certain species of these, such as *Streptococcus salivarius.* An increase of one kind of organism is accompanied by a corresponding increase in the other organisms. This regulation would affect both the nos. within and the proportions among species and would be a mark of the individual.

Incidence and characteristics of beta radiation survivors (Escherichia coli).

Koh, W. Y., Morehouse, C. T., and Chandler, V. L. (Ethicon Inc., New Brunswick, N. J.). *Appl. Microbiol., 4* (3), 153-5 (1956).

It was found that isolates of *Escherichia coli* which resisted the high radi-

ation dosages employed were not spontaneously occurring mutants. These survivors were identical to the parent in their susceptibility to radiation, catalase activity, and nutritional requirements. Electron beam irradiation did not appear to induce radiation-resistant mutants in this strain of *Escherichia coli*.

The characterization and properties of wild yeasts of importance to the food industry.

Morris, E. O. (Brewing Industry Research Foundation, Engl). *Chemistry & Industry No. 49*, 1591-2 (1956).

The methods employed for the isolation of wild yeasts were discussed under three headings: :(a) those which were aimed at inhibiting mold infections; (b) those which were of value for the isolation of a wide variety of yeast species from a process-yeast; and (c) the use of giant colony characteristics as a means of establishing strain differences within a single species. Methods employed in the preservation of yeast cultures were discussed and the results of preliminary investigations into the application of freeze-drying techniques were presented.

NUTRITION

Diet and serum cholesterol in man: Lack of effect of dietary cholesterol.

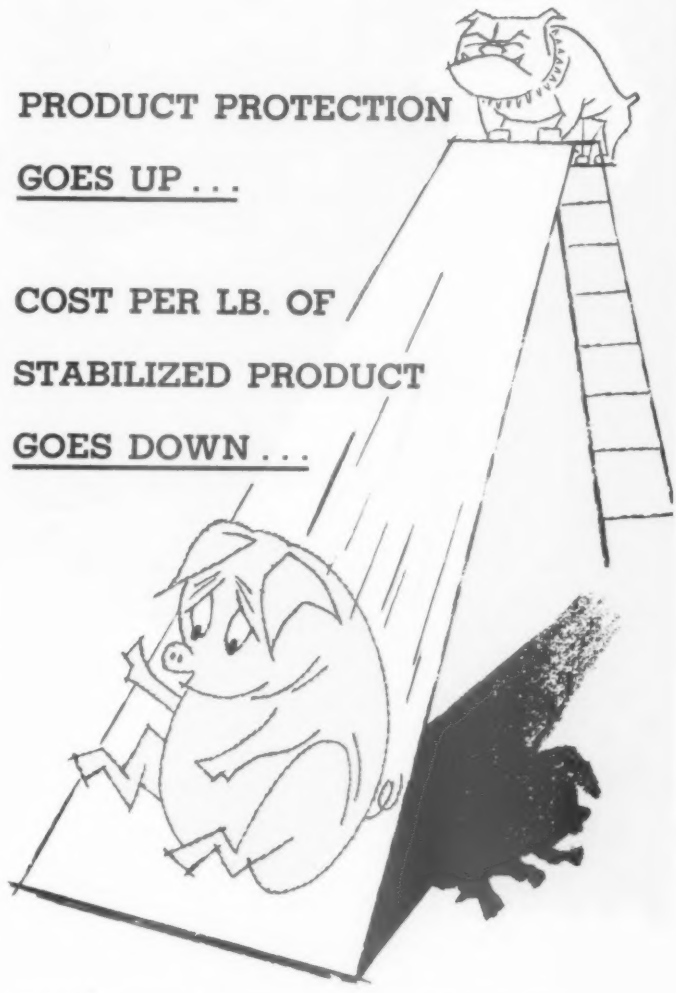
Keys, A., Anderson, J. T., Mickelsen, O., Adelson, S. F., and Fidanza, F. (Univ. of Minnesota, Minneapolis). *J. Nutr., 59* (1), 39-56 (1956).

Surveys showed no relationship between dietary cholesterol and the total serum cholesterol concn. over most of the ordinary intake range characteristic of American diets. It failed to show any difference in the serum chlosterol concns. of men of the same age, phys. activity, relative body wt. and general dietary pattern but differing markedly in cholesterol intake. Men whose diets were consistently very low in cholesterol showed that their serum values did not differ from men of the same age and economic status whose diets were very high in cholesterol. It is concluded that in adult men the serum cholesterol level is essentially independent of the cholesterol intake over the whole range of natural human diets. It is probable that infants, children and women are similar.

The effects of supplementary calories on nitrogen storage at high intakes of protein in patients with chronic liver disease.

Plough, I. C., Iber, F. L., Shipman, M. E., and Chalmers, T. C. (Walter Reed Army Med. Center, Washington 12, D. C.). *Am. J. Clin. Nutr., 4* (3), 224-30 (1956).

In 3 patients with liver disease large supplements of carbohydrate or fat spared amts. of N varying from 1.4 to 6.5 mg. per added calorie. The amts. of N spared per added cal. was directly related to the level of protein in the diet. It is suggested that at lower protein intakes an excess



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of cals. leads to the formation of fat, but at higher protein levels leads to the formation of lean tissue.

Nutritional status of industrial workers. I. Dietary, blood and physical findings.

Babcock, M. J., Church, H. N., and Gates, L. O. (N. J. Agr. Expt. Sta., New Brunswick, N. J.). *Milbank Mem. Fund Quart., 32* (4), 323-42 (1954); *Biol. Abstr., 30* (2), No. 4167 (1956).

Dietary, blood and phys. findings were evaluated to characterize the nutritional status of a group of 610 male industrial workers. The evaluation was based on individual findings for dietary nutrients, blood constituents, and phys. signs, and also collectively on arbitrary combinations for these 3 measures for each subject. About ¼ of the men gave some evidence of suboptimal nutrition with respect to one or more nutrients. No cases of acute nutritional deficiency were observed. The most common nutrients for which deficiencies were noted were: Ca, P, thiamine, riboflavin, and ascorbic acid. Suboptimal nutrition and obesity were noted in all levels of education, age, income, and ethnic group. Low consumption of milk and vitamin C-rich vegetables and fruits, and high intake of pastries, bread, sweetened beverages and candy bars were responsible for much of the suboptimal nutrition observed. Inadequate breakfasts and between-meal snacks of sweet food were contributing causes of unbalanced diets.

The effect of methionine supplementation upon the tumor-host relationship in the rat.

Allison, J. B., Wannemacher, R. W., Hilf, R., and Hetzel, C. A. (Rutgers Univ., New Brunswick, N. J.). *J. Nutr., 59* (1), 27-38 (1956).

Data are presented to demonstrate that the gain in wt. of a transplanted sarcoma was independent of the gain in body wt. of rats fed a 12% casein diet. Supplementation with methionine did not alter this independence but did increase the rate of gain of the body with respect to the tumor. Adding more N in the form of glycine or guanido-AcOH together with the methionine, increased this rate of gain of the body sitll further and evidence is presented to show that the rate of growth of the tumor was depressed in the larger animals fed the mixed supplements.

A nutritional requirement for bromine.

Huff, J. W., Bosshardt, D. K., Miller, O. P., and Barnes, R. H. (Sharp and Dohme Res. Labs., West Point, Pa.). *Proc. Soc. Exptl. Biol. Med., 92* (1), 216-19 (1956).

Addition of an iodinated casein with thyroid activity to a purified diet adequate in all known essential nutrients produced a growth retardation in mice. Growth inhibition was reversed by fractions of whey and by whey ash. The active inorganic component was found to be bromine.

The effect of aureomycin on the gut of the pig.

Braude, R., Coates, M. E., Davies, M. K., Harrison, G. F., and Mitchell, K. G. (Natl. Inst. for Res. in Dairying, Univ. of Reading, Engl.). *Brit. J. Nutr., 9* (4), 363-8 (1955).

Antibiotics given in the diet have been shown to reduce the wt. of the pigs intestine. In this study involving 52 pigs, aureomycin was found to decrease the wt. of the gut. No chem. or histological changes were detected. There was no significant effect on the wts. of the liver, kidney, or spleen.

The critical world food situation.

Sure, B. (Univ. of Arkansas, Fayetteville). *Am. J. Clin. Nutr., 4* (3), 211-23 (1956).

Over two-thirds of the world's population are ill-fed and ill-nourished. The result is high incidence of disease and a life expectancy of only 26 to 30 years which may be related to a low protein intake and inadequate consumption of vitamins and minerals. It was suggested that the following measures may help to improve the world food situation: 1) proper food combinations, 2) amino acid enrichment, 3) use of leaf crops as a source of proteins, 4) use of food yeasts, 5) use of algae, and 6) increased consumption of soybean, peanut, and fish products of high protein content.

PHARMACOLOGY AND TOXICOLOGY

Toxicity studies on captan-treated corn in pigs and chickens.

Link, R. P., Smith, J. C., and Morrill, C. C. (Univ. of Illinois, Urbana). *J. Am. Vet. Med. Assoc., 128* (12), 614-16 (1956).

Pigs and chickens were fed, without harmful effects, balanced rations which contained captan-treated corn. This conclusion is based on the favorable wt. gains in the pigs and chickens and the absence of detectable pathological changes in the tissues of these animals. Chickens fed captan-treated corn had statistically significant increased gains over the controls. The amt. of captan (580 p.p.m.) on the corn used in this study is the amt. regularly recommended to treat corn used for seed.

PHYSIOLOGY AND MEDICINE

High fluoride content of teeth from communities with low fluoride water supplies.

Shaw, J. H., Gupta, O. P., and Meyer, M. E. (Harvard Sch. of Dental Med., Boston, Mass.). *Am. J. Clin. Nutr., 4* (3), 246-53 (1956).

The F content of enamel and dentine from teeth of residents in Delhi, Bombay, and Boston were compared. The F values from individuals in Delhi and Bombay had a much higher F content than would be expected in view of the low F content of the H_2O in these communities. Possible explanations for the difference in F content between the teeth of Boston and

Indian individuals are probable higher H_2O consumption, use of sea salt or other F sources, or a higher utilization of ingested fluorides.

The effect of sugar supplements on dental caries in children.

KING, J. D., MELLANBY, M., STONES, H. H., AND GREEN, H. N. Med Research Council (Brit.) Spec. Rept. Ser. 288, 1-55 (1955); *Biol. Abstr., 30* (1), No. 1504 (1956).

In 3 independent studies, dental caries was compared over 1, 1.5 and 2 yrs. in control groups of adequately nourished children in residential homes and somewhat longer exptl. groups fed addnl. sugar with meals. In London 265, aged 2-4 yrs. received 11.5 oz. addnl. sugar for 1 yr. and 15.2 for 2 yrs. In Liverpool 77, aged 4-14 yrs. were given a 37 oz. weekly supplement for 1 yr. and 57 for 2 yrs.; in Sheffield, 42 aged 4-14, received a 44.5-45.5 oz. supplement for 1 yr. and 66 for 2 yrs. On the basis of clinical dental examn. which recorded both new caries and caries extension, it was concluded that provided a child is fed a good diet a substantial increase in sugar will not affect liability to caries. No significant differences were found in lactobacillus counts or salivary buffering capacity between control and exptl. groups.

Clinical trials with a new antianemic agent—Acidiron.

BLAUSTEIN, A. (N. Y. City Hosp., Welfare Island, N. Y. C.). *J. Am. Geriatrics, 3* (2), 120-4 (1955); *Biol. Abstr., 39* (1), No. 1530 (1956).

An old concept of the use of HCl along with Fe therapy is again presented. Case studies bear out the need for more frequent use of HCl as an adjunct to Fe therapy in elderly individuals. Acidiron is specially designed to stimulate the gastric mucosa with HCl before the ferrous sulfate is made available to the stomach. It appears from the clinical evidence that HCl when liberated as described, activates the stomach to a physiologic state which is conducive to a more efficient system utilization of Fe.

Cholesterol in various foods.

OKEY, R. *J. Am. Med. Assoc., 161* (7), 669 (1956).

A table of a list of foods giving the amt. of cholesterol present for a certain wt. of each food is given.

FOOD AND FOOD TECHNOLOGY

COFFEE AND TEA

Carbohydrates of the coffee bean.

PLUNKETT, R. A. (Ohio State Univ.) *Dissertation Abstr., 16,* 455 (1956).

Describes a survey of the carbohydrates of the green coffee bean (Santos) and a characterization of noncarbohydrate constituents incidentally encountered. Paper and column chromatographic techniques for the detection of caffeine are given. The polysaccharide, pectin and hemicellulose fractions of coffee bean were studied primarily.

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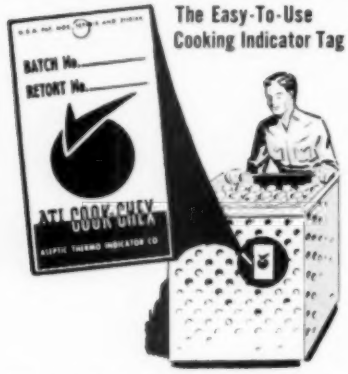

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Can chemists measure tea quality?

ANON. *Coffee & Tea Ind., 79* (7), 37 (1956).

An attempt was made to evaluate the aroma and taste of coffee and tea by chem. means instead of by smell and taste, but with no success.

FATS AND OILS

Nutritive value or toxicity of highly unsaturated fatty acids. II.

KANEDA, T., SAKA, H., AND ISHII, S. (Tokai Regional Fisheries Lab., Tokyo, Japan). *J. Biochem.* (Japan), *42*, 571-73 (1955); *Fats, Oils Det., 13*, A:164 (1956).

Unoxidized Et esters of highly unsatd. fatty acids are not toxic. The toxic effects observed when autoxided highly unsatd. Et esters are fed to rats appear to be due to the peroxide as neither the oxidation products forming urea adducts, reduced peroxides, or polymerized highly unsatd. esters were toxic.

Improved method for determining gossypol in crude cottonseed oils.

PONS, W. A., MITCHAM, D., O'CONNOR, R. T., AND STANSBURY, M. F. (Southern Regional Research Lab., New Orleans, La.). *J. Am. Oil Chemists' Soc., 33* (7), 324-30 (1956).

The *p*-anisidine method for the detn. of gossypol in crude cottonseed oils was reinvestigated and modified to make it applicable to all crude oils obtained by the newer methods of processing cottonseed. The modifications include a change in the compn. of the solvent, a higher reaction temp., and the use of a more concd. *p*-anisidine reagent.

GELATIN AND GUMS

The swelling of gelatin films. The effects of drying temperature and of conditioning the layers in atmospheres of high relative humidity.

JOPLING, D. W. (Kodak Ltd., Wealdstone Harrow, Middlesex). *J. Appl. Chem., 6*, 79-84 (1956).

Gelatin layers show min. swelling when the temp. of the layer during drying is about 35°. When dried at a higher temp., the layer is "sol-like" and bonding does not occur until the layer is swollen or conditioned at a high relative humidity.

MILK AND MILK PRODUCTS

Radiation preservation of milk and milk products. I. Background and problems.

GOLDBLITH, S. A., AND PROCTOR, B. E. (Massachusetts Inst. of Technol., Cambridge). *J. Dairy Sci., 39* (4), 374-8 (1956).

Milk and other dairy products were found to be most sensitive to ionizing energy. Analysis of the fundamental direct and indirect effects of radiation indicates that the most desirable situation to achieve is one wherein the indirect effect is minimized to the greatest possible degree and the direct effect utilized solely for destruction of microbes. Fluid milk was shown to be very sensitive to radiations. Radiation-induced off-flavor threshold detection levels occur at doses approx. 1/100th of the levels required for sterilization.

A survey of various free amino and fatty acids in domestic Swiss cheese.

HINTZ, P. C., SLATTER, W. L., AND HARPER, W. J. (Ohio State Univ., Columbus). *J. Dairy Sci., 39* (3), 235-44 (1956).

Cheeses were analyzed by means of a polystyrene ion-exchange method for free amino acids. Determinations were made by buffered silica gel chromatography of the free fatty acids or groups. Not all of the free amino acids were always present in the cheeses. Only cysteic acid, threonine-serine, glutamic acid, and tyrosine-phenylalanine were present in all samples. A min. proline concn. of 2.0 mg. per g. and a min. propionic acid concn. of 5.0 mg. per g. of cheese were present before the cheese possessed a satisfactory Swiss cheese flavor.

INDUSTRIAL HEALTH

The problem of trichloroethylene in occupational medicine.

BARDODEJ, Z., AND VYSKOCIL, J. (Obranska 127, Brno 14 Czech.). *Arch. Ind. Health, 13* (6), 581-92 (1956).

Trichloroethylene is above all a nerve poison. The highest allowable trichloroethylene concn. in the air (0.4 mg. per l. for Czechoslovakia, 100 or 200 p.p.m. for U. S. A.) is too liberal and a lowering to 0.2 mg. per l. in Czechoslovakia, better still to 0.05 mg. per l., is advocated. The finding of 160 mg. of trichloroacetic acid in a l. of urine indicates that the max. allowable concn. was exceeded, and that even lower values do not exclude that possibility. The employees should take care to get sufficient exercise in the open air, as this aids exhalation of the noxious vapor and supports oxidation. The administration of vitamins of the B group and of ascorbic acid has proved useful. Food rich in proteins helps persons threatened with intoxication.

Toxicological studies on hydrocarbons. II. A comparative study of the effect of benzene and certain mono-n-alkylbenzenes on hemopoiesis and bone marrow metabolism in rats.

GERARDE, H. W. (Rutgers Univ., New Brunswick, N. J.). *Arch. Ind. Health, 13* (5), 468-74 (1956).

Benzene administered subcutaneously to rats at a daily dosage of 1.0 ml. per kg. of body wt. for 14 days causes a loss in body wt., a leucopenia, involution of the spleen and thymus, and a decrease in femoral marrow nucleated cell count and nucleic acid. The hematocrit was not significantly affected. Rats given the same dosage of toluene, ethylbenzene, normal propylbenzene, and normal butylbenzene gained wt. and had a normal or increased peripheral blood leucocyte

count, thymus and spleen wt., femoral marrow nucleated cell count, and femoral marrow nucleic acid.

PACKAGING

Cellophane pliability tester.

CONTI, J. D. (Am. Viscose Corp., Phila.). *Modern Packaging, 29* (11), 124-5* (1956).

The instrument measures loss or gain by stretch of film tested, which is found to be roughly proportional to the moisture content.

Aerosol packaging seen invading food field.

Food in Canada, 30, June 1956.

At the 42nd annual meeting of the Chem. Specialties Manufacturers Assoc. in N. Y., W. Earl Graham pointed out the wide range of potential food aerosols, and the problems involved. Some of them are: (1) phys. characteristics such as viscosity and gas soly.; (2) biologic stability or preservation; (3) economic considerations; and (4) Federal, State and local food laws. He also suggested the use of an inner plastic container holding the product to be dispensed sep. from the propellant gas for food products which cannot be aerated.

RADIOCHEMICAL TECHNOLOGY

Prevention of intestinal radiation death by removal of the irradiated intestine.

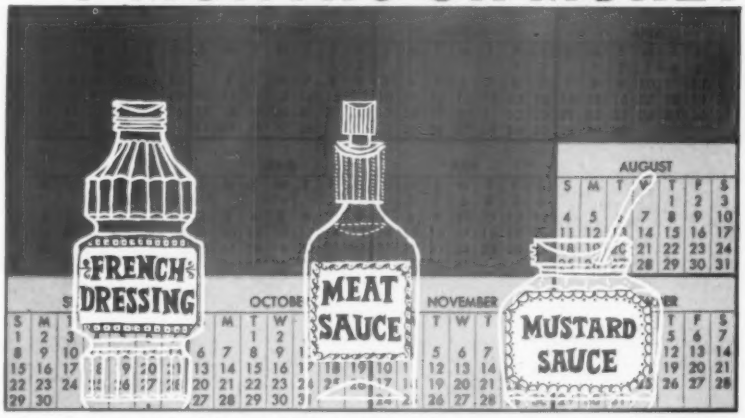
OSBORNE, J. W. (Univ. of Illinois, Urbana, Illinois). *Radiation Research, 4,* 541-6 (1956).

Animals with only 20% of the intestine irradiated lived about 12 days. Exposure of 50% or 80% of the exteriorized intestine produced death in about 5.5 days, with no animal living longer than 7.4 days. The histological changes were qualitatively the same in all groups of animals checked, although denudation of the intestinal epithelium was slower in "intestine-irradiated" animals. Surgical removal of the exposed portion in "intestine-irradiated" animals provided indefinite survival in one-third of the animals (6 lived indefinitely, 3 died from complications after having outlived the controls). Since it was possible to save animals by removing the irradiated portion as late as 96 hrs. after exposure, the conclusion is that in order to cause death the irradiated portion must remain in the body almost the entire life expectancy of the animal.

Modification of radiation injury in the rabbit.

JACOBSON, L. O., MARKS, E. K., AND GASTON, E. O. (Univ. of Chicago, Ill.). *Proc. Soc. Exptl. Biol. Med., 91* (1), 135-9 (1956).

At last! Positive way to SOLVE INSTABILITY of food emulsions --7 MONTHS OR MORE!



KELCOLOID hydrophilic colloid

KELCO REFINED ALGIN PRODUCTS

lengthens shelf life of French and Salad dressings, meat and barbecue sauces

You produce stable and uniform emulsions of superior flavor release and natural color with Kelcoloid. This easy-to-use hydrophilic emulsifying colloid improves consistency, gives smoother textured dressings of higher gloss.

for French dressings:

Extensively used in French dressings, Kelcoloid gives greater emulsion stability and markedly increases shelf life. Even when dressings are subjected to either high transit and storage temperatures, or refrigeration, Kelcoloid protects against body breakdown and separation.

for salad dressings and food spreads:

For softer, smoother texture add Kelcoloid to produce a desirable body that resists cracking and oil separation even on long standing.

for barbecue, meat, seafood, and mustard sauces:

With Kelcoloid you produce a properly stabilized product with optimum body and clean full flavor. Shelf life is increased for Kelcoloid maintains uniform emulsions longer.

For finer food emulsions Kelcoloid is well worth your immediate evaluation.

YOURS ON REQUEST: Free Kelcoloid Sample and Technical Bulletin, fully describing application of Kelcoloid in food emulsions, yours without obligation. Write today.

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a product of **KELCO** company

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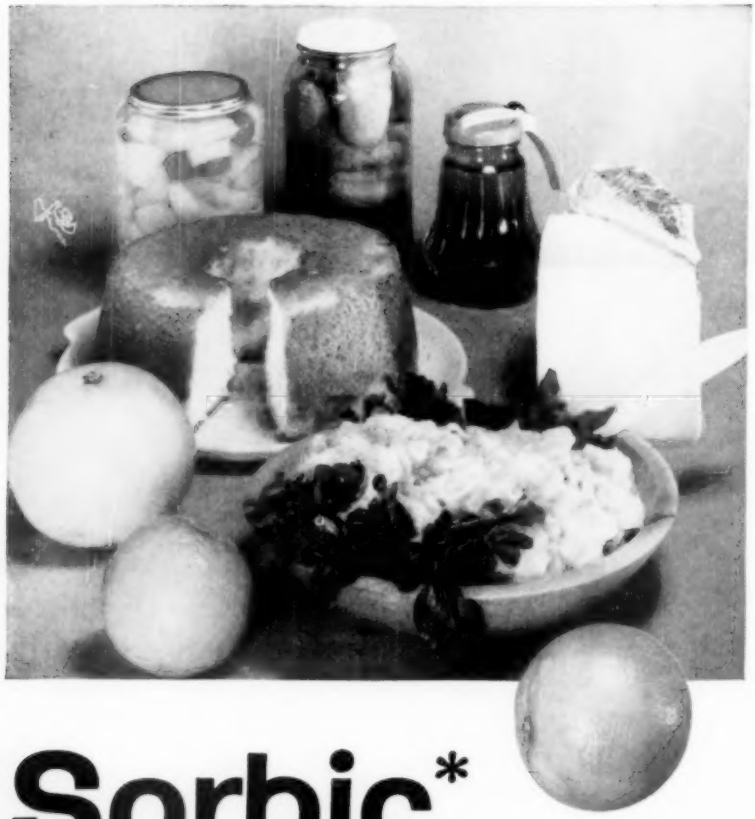


Sorbic*

the modern food preservative

protects natural quality...

CONSIDER SORBIC FOR...

CHEESES
CAKES
PICKLES
SALADS
CITRUS PRODUCTS
SIRUPS

- Controls growth of many molds and yeasts.
- Safe at required levels—it is metabolized like fatty acids in foods.
- Contributes no flavor or odor—when properly used.

For further information on how you can protect your food product with Sorbic, write the CARBIDE office nearest you for Technical Bulletin F-6568. Offices in principal cities. In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Montreal.

*CARBIDE's *refined sorbic acid for use in foods.*

CARBIDE and CARBON CHEMICALS COMPANY

A Division of
Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.

Postirradiation injection of mouse embryo cells or baby mouse liver or spleen cells enhances significantly the survival of rabbits exposed previously to 900 r total body x-irradiation without producing an appreciable effect upon hematologic recovery as observed in the peripheral blood.

PATENTS

Method of inhibiting bacteria, mold, fungus, etc., growth in citrus fruits, and other fresh foods.

KELLER, H. J. Assignor to Minute Maid Corp. U. S. 2,748,004, May 29, 1956.

A method of inhibiting the development of destructive organisms in fruits and vegetables including citrus fruit comprising the step of subjecting the same at least about twenty-four hrs. in a closed space to an atm. contg. a member of the group consisting of tetrachloroethane and pentachloroethane gas, wherein the concn. for each one hundred cu. ft. of unoccupied space ranges from about 30 to 70 cu. cm. of liquid for the member.

Cheese packaging.

INGLE, J. D., AND NAWROCKI, A. N. Assignors to Swift & Company. U. S. 2,753,268, July 3, 1956.

A method for packaging cheese to inhibit mold growth thereon comprising: forming a wrapper of a pliable, flexible material; placing a body of a cheese selected from the group consisting of pasteurized process cheeses and fully-cured natural cheeses which no longer evolve any substantial amt. of gases within the wrapper; flushing the wrapper and the cheese with CO_2 gas; drawing a vacuum on the wrapper and cheese to remove substantially all of the CO_2 and other gases surrounding the same; and sealing the package while under the vacuum to produce a package which upon standing develops a greater degree of vacuum than was applied thereto before sealing through the absorption of the CO_2 remaining in the package by the cheese.

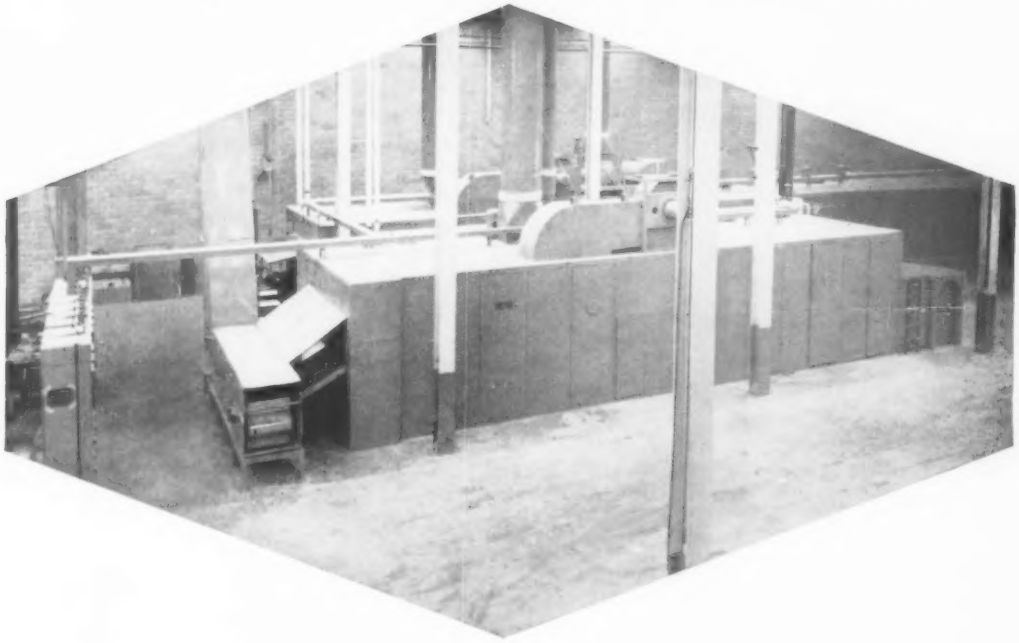
Flavored drinking straw machine and method.

RABIN, S. F., AND SCISOREK, M. Assignors to Jere Bayard, S. F. Rabin, M. Scisorek. U. S. 2,753,267, July 3, 1956.

A drinking straw comprising a tubular body element having resilient side walls and a self-sustaining elongated thin and flavor-coated strip element positioned longitudinally in the tubular body element with portions in frictional engagement with corresponding opposed inner side walls of the tubular body, one of the elements being held resiliently distorted by the engagement with the other element whereby to frictionally retain the strip in the tubular body.

A Proctor

DRYING RANGE means HIGHEST PRODUCT UNIFORMITY!



Efficient drying per pound of product can often *mean more direct profit to you* than an increased sales volume! Proctor equipment provides the control, flexibility, and construction features *essential* to profitable drying performance. The result—increased yield of highest quality product. Write or phone *today* for complete information.

Product Uniformity is of utmost importance to every food processor, at all stages of processing.

Shown above is one of many Proctor & Schwartz dryer installations in one of the country's larger food plants—typical of the many in use in the food industry today. Here, because of Proctor drying skills, uniformity of color, taste, and overall customer appeal is maintained at uniformly highest levels—yields are greatly increased!

★ PROFITABLE OPERATION
★ INCREASED YIELD
★ GUARANTEED PRODUCT QUALITY
★ "W/M" CONSTRUCTION
★ FLEXIBILITY OF OPERATION

PROCTOR DRYING EQUIPMENT FOR THE FOOD AND PROCESS INDUSTRIES

• Tray Dryers • Truck Dryers • Pre-Forming Feeds
• Continuous Conveyor Dryers • Spray Dryers

Proctor

PROCTOR & SCHWARTZ, Inc.

Manufacturers of Industrial Drying Equipment and Textile Machinery, Philadelphia 20, Pa.

You can duplicate this profitable success story

Promotion-Minded Packer

Here's how Scott Petersen carried out "Flavor-Improved" drive

Huron man helps explain the promotion to interested routemen . . .

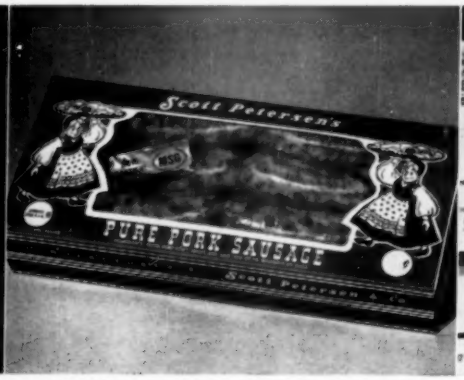
A whopping 25% increase in sales volume has rewarded the Scott Petersen Company's recent flavor-improvement decision and "tell-them-about-it" merchandising campaign . . . built around use of Huron MSG!

Scott Petersen, Jr., dynamic president of the Chicago sausage kitchen, was convinced by independent taste tests of Huron MSG's effectiveness in intensifying fresh pork sausage flavor. He incorporated the "Taste-Maker" into his seasoning. Then, in cooperation with Huron, a full-scale merchandising drive was launched through routemen.

The complete "Even tastier today . . . because MSG is in it" story was carefully explained by Scott Petersen management and Huron representatives. Routemen were supplied with colorful in-store display materials and ad reprints. Pressure-sensitive stickers repeated the "now tastier" theme from each product package.

The enthusiastic routemen went out and *sold* . . . convinced retailers *sold* . . . pleased customers by the thousands tried the sausage and soon were *back for more*. Contact Huron *today* if you'd like to boost your sales the same way. Like Huron MonoSodium Glutamate 99+% Pure itself, this tested promotional idea can work wonders for your product.

Full-page, four-color newspaper ad gets the story to consumers . . .



Package stickers carry the theme to the point of purchase . . .

Routeman uses material to sell larger order: "So you'll have enough on hand" . . .

And don't overlook this versatile favorite

Huron HVP

HYDROLYZED VEGETABLE PROTEINS
THE FLAVOR OF MEAT FROM WHEAT

available in a full line of powders, pastes and liquids to add the mouth-watering richness of braised beef . . . at surprising economy

BOOSTS SALES 25%

by merchandising the better flavor Huron MSG builds in pork sausage

Stores feature the product in traffic-stopping displays...

Promotion results in thousands of added sales all over Chicago.

You can get these effective hangers and talkers, with blank imprint space, and other material from Huron... send for details *today*.

YOUR ONE SOURCE FOR BOTH THESE TASTE-BUILDERS

Huron **THE HURON MILLING COMPANY**

MSG • HVP • AGE-IT
American Pioneers in Protein Derivatives

Executive Office: 3101 N. WOODWARD AVE., P. O. BOX 9, ROYAL OAK, MICH.
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dry flavors
"FLAV-O-LOK"
A highly suitable line of dry flavors for use in DRY-MIXES, such as: Gelatin desserts, pudding powders, beverage powders, sherbet mixes, pie-filling powders, etc.

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Lemon	Apricot	Cola
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Orange	Currant	Spearmint
Tangerine	Grape	Peppermint
Raspberry	Pineapple	Sassafras
Apple	Butterscotch	Punch
Strawberry	Methyl Salicylate	

Superb in taste and Keeping properties

FOOD INDUSTRY TOPICS

(Continued from page 34 preceding technical papers)

change reflects the company's increased emphasis on food materials, which now include vegetable shortenings, salad oils, and soybean flour.

◆ ◆ ◆

Consolidated Foods Corporation has announced acquisition of the Kitchens of Sara Lee, Inc., Chicago, one of the nation's leading producers of premium quality baked goods. Mr. Chas. W. Lubin will continue as president of the latter firm, which will be operated as a separate subsidiary, with no change in present company management or policy.

◆ ◆ ◆

Plans for construction of a $1 million plant for American Can Company in Puerto Rico were announced by Teodoro Moscoso, administrator of Puerto Rico's Economic Development Administration. Work on the plant, which will have a capacity for producing about 150 million cans yearly for Puerto Rican food canners, will start early this fall. The building will be constructed by the Puerto Rican Industrial Development Administration, and equipped and operated by the can company under a 10-year self-amortizing lease. Operation of the plant, to be located about 10 miles southwest of San Juan, will be by Puerto Rican Can Co., a wholly owned Canco subsidiary.

◆ ◆ ◆

The 14 scattered buildings currently housing activities of Adolph's, Ltd., manufacturers of Adolph's Meat Tenderizer, Adolph's Salt Substitute, and other food products, soon will give way to this million dollar block-long structure in Burbank, Calif., designed to contain a research laboratory, test kitchen, and all company offices. An outstanding feature of the new building, scheduled for completion in 1957, will be a perforated aluminum screen enveloping the building on three sides and assuring privacy of all offices, yet allowing full use of natural light.

◆ ◆ ◆

Case sales of Libby, McNeill & Libby products have increased 150% in the past 10 years, according to Libby President Chas. S. Bridges, who added that the year ended June 2, 1956, was the best in the company's history. Shareholders of the company approved an increase in the authorized common stock from 4,000,000 to 6,000,000 shares, and also unanimously elected the management slate of directors.

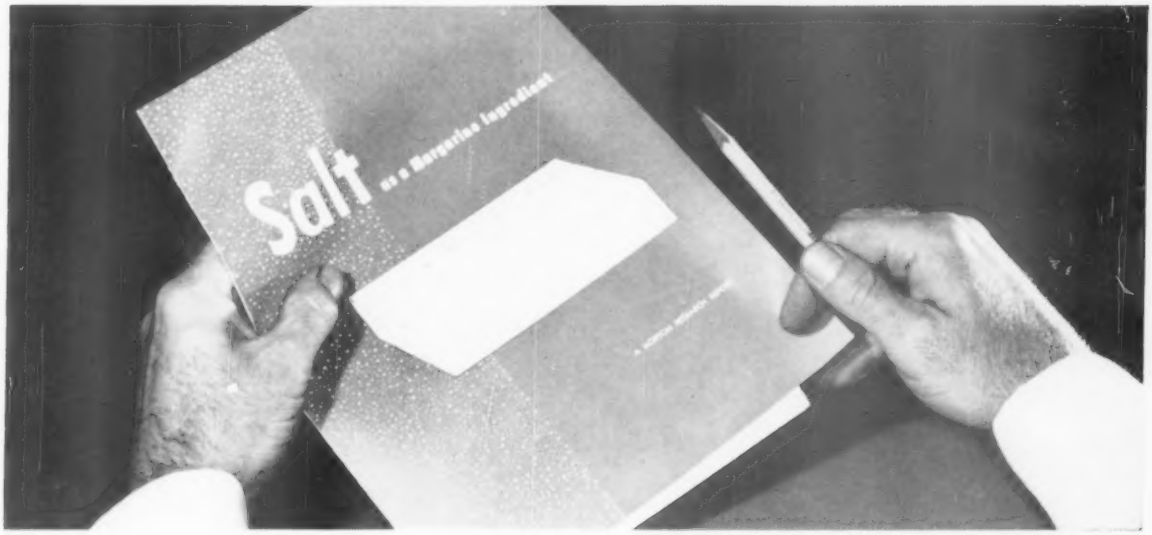
◆ ◆ ◆

Substanial increases in both sales and net earnings were registered by Stokely-Van Camp, Inc., during the fiscal year ended May 31, 1956. Net sales rose to the highest level in the firm's history, totaling $159,527,214, compared with $136,492,148 in the preceding fiscal year, a gain of 17%. Net income increased for the fifth consecutive year. It amounted to

(Continued on page 52)

Morton Salt Company's new million dollar laboratory at Woodstock, Illinois, is at the service of the Food Industry to help solve problems relating to the use of salt. One type of service Morton offers is research reports like this . . .

New booklet about salt for making margarine



This fact-packed 6-page booklet, filled with interesting pictures and tables, gives up-to-date information on salt as a margarine ingredient. It shows the chemical and physical composition of available margarine salt as compared to the margarine product. It points out the effect of impurities in salt on the flavor and keeping qualities of margarine. And it explains quality control methods that may be used to evaluate margarine salt quality.

This booklet also shows how Morton '999' Salt more than meets the specifications for a margarine salt. '999' is a high purity, low cost salt which contains 99.9% clean, pure sodium chloride, exceptionally low in the objectionable trace metals, copper and iron. '999' is an evaporated granulated salt that won't break up in shipment and will dissolve uniformly. Morton '999' Salt has a practically constant weight per volume and is easily and efficiently dispensed by hand or machine.

Free Service Helps Morton Offers You

If you use salt for canning, packing or processing any food product, chances are Morton can help you make a better product for less money. In addition to free booklets and reports on salt for the Food Industry, Morton offers the services of one of their Food Technologists to assist you with on-the-spot help with any problem pertaining to salt. And he's backed by the services of chemists and salt scientists at Morton's ultra-modern research laboratory.

Remember, too, Morton makes many grades of salt for the Food Industry, and only Morton has 9 strategically located plants to serve you. We offer fast delivery from a bag to a trainload at favorable prices and freight, *anywhere* in the country.

Mail coupon today!

- ☐ Please send me your free booklet: "Salt as a Margarine Ingredient."
- ☐ I am not a margarine manufacturer, but would like more information on how Morton can help me _____

Name _____

Title _____

Company _____

Street _____

City _____ Zone _____ State _____

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INDUSTRIAL DIVISION
Dept. FT-10 120 So. La Salle Street, Chicago 3, Illinois

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MANUFACTURING
PLANTS OF TODAY

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BRAND
Spice oils

The finest spice oils can be recognized by the Pyramid Brand . . . the peak of quality at economy prices.

P&S experts, located in buying markets throughout the world, accept only the finest grades at the proper buying seasons.

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ANISE	CLOVE	NUTMEG
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Offices: Chicago, Ill.; Cinn., Ohio; Los Angeles, Calif.; Toronto, Can.
Plants: Teterboro & Guttenberg, N. J.; Culver City, Calif.; New York, N. Y.

(Continued from page 50)

$4,495,453, compared with $3,781,915 in the 1955 fiscal year, an increase of 19%.

◆ ◆ ◆

Fischer & Porter Co., Hatboro, Pa., has changed the name of its Chlorination Division to Water & Waste Division in an effort to describe more accurately F&P's activities in water treatment, sewage treatment, and industrial waste fields through the sale of engineering services, chlorination and other chemical feed equipment, and instrumentation.

◆ ◆ ◆

Formation of Norwalk Plastics Company to take over the plant and physical assets of Lincoln Plastics Corp., Norwalk, Conn., has been announced. The new firm will concentrate its operations on injection molding of thin-wall, transparent containers and similar precision-molded products in those fields where high speed, completely automatic equipment is required.

◆ ◆ ◆

On September 1, NBC commentator Alex Dreier initiated a new 5-minute show called "Topic for Today," sponsored by Morton Salt Co., 120 S. LaSalle St., Chicago. The show is aired over the NBC radio network every Saturday, following the National Farm and Home Hour, and promotes Morton Salt products for farm, home, and industry.

◆ ◆ ◆

Formation of Texas Brands, Inc., as a Texas corporation to process and distribute nationally a major line of "Texas style" frozen and canned cooked foods under the label of Texas Brands is announced. The new company, headquartered at 107 Ogden Lane, San Antonio, combines three long-established food processing firms in southern Texas: Winter Garden Processors, Carrizo Springs; Crystal City Canneries, Crystal City; and Schmidt Canning Co., San Benito. Food brokers in major market areas of the country now are being appointed in a concentrated effort to build immediate national distribution for the new line.

◆ ◆ ◆

A new $150,000 Industrial Toxicology Laboratory has been completed by Industrial Bio-Test Laboratories, Inc., in Northbrook, Ill., a Chicago suburb. According to Dr. Jos. C. Calandra, Bio-Test president, the new facilities provide industry with comprehensive biological evaluations at a time when new materials and chemicals used by the public are creating problems in public health and welfare. The research firm's address is 1810 Frontage Rd., Northbrook, Ill.

. . . *the human element*

Dr. Donald A. M. Mackay, a member of IFT, has been appointed associate director of research of Evans Research and Development Corp., 250 E. 43rd St., New York 17, N. Y. A specialist in applying spectrophotometric and chromatographic techniques to problem solving in chemical research, he is one of the inventors of the recently announced process for restoring fresh natural flavor to a wide variety of processed foods by use of enzymes. The firm also

(Continued on page 54)

the Pfizer TV* story...

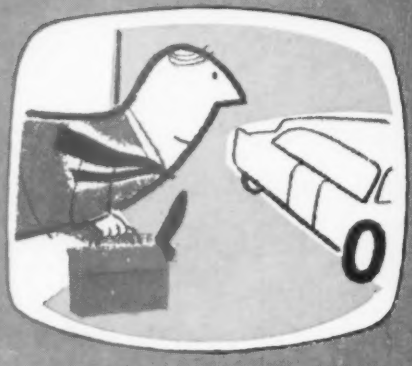
puts you in the starring role

*(This TV stands for the Tremendous Versatility of Pfizer Chemicals)

This is a story about you and the role Pfizer chemicals can play in your daily life. (Just a few examples). *Fanfare...lights...camera...*

MORNING SCENE:...You, contemplating yourself in bathroom mirror. Headachey? Cold coming on? You reach for tablets made with Pfizer Acetophenetidin (for pain relief) and Pfizer Caffeine, always of highest purity...Next...

BREAKFAST SCENE: Biscuits? Vitamin-enriched with Pfizer Bi-Cap. Jelly? Pfizer Citric Acid brings out true fruit flavor. Frozen peaches on cereal? Better color and flavor, thanks to Pfizer Ascorbic Acid. Even the...oops! We're lagging...



"OFF-TO-WORK" SCENE: You're rushing out now, into shiny car. Shiny? Sure! Pfizer acids (e.g. Citric and Tartaric) offer a wide application in metal cleaning, polishing and plating. Now we "dissolve" (as they say in TV) to...

OFFICE SCENE: You're studying blueprints...far easier to read...Pfizer Oxalates give blueprint papers special vivid blue color. We could go on with many more examples. Our point is... well, here's a brief "commercial"...

PUT MORE SELL IN *YOUR* LINE WITH PFIZER PRODUCTS.

Manufacturing Chemists

Pfizer

for Over 100 Years

These are some of the bulk products of the Pfizer Chemical Sales Division used in over 150 different industries:

• Citric, Tartaric, Oxalic Acids and Salts • Ascorbic Acid • Caffeine • Itaconic Acid • Vitamins • Antibiotics • Hydrocortisone • Reserpine • Plasticizers

For further information contact:

CHAS. PFIZER & CO., INC.

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630 Flushing Ave., Brooklyn 6, N. Y.
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Acknowledgment: "This is Your Life", NBC-TV is the property of Ralph Edwards Productions.

Open new markets with the help of EASTMAN antioxidants

Ever develop a food product which could be given only local distribution—or perhaps couldn't be marketed at all—because of limited stability? If so, it probably contained an oxygen-sensitive ingredient, such as an oil or a fat, which caused the trouble.

Let Eastman help you combat this problem with its complete line of Tenox antioxidants. Our staff of food technologists would welcome the opportunity of working with you on the proper use of these antioxidants. Assisting other food processors in this manner, we have helped send many fine products from the laboratory shelves to the market place.

Since Eastman manufactures the widest range of antioxidants, we have no axe to grind in favor of any one. You can be certain our recommendation will represent the most economical and effective stabilization possible against oxidative deterioration.

For more information about Tenox, write to Eastman Chemical Products, Inc., Kingsport, Tennessee—a subsidiary of Eastman Kodak Company.

Tenox Eastman food-grade antioxidants

(Continued from page 52)

announces election of **Dr. Everett G. McDonough** as executive vice president, and appointment of **Dr. Lloyd K. Riggs** as senior scientist, specializing in food research. Dr. McDonough has been vice president and general manager of the company since its formation in 1946. He is also a director and chairman of the executive committee. Dr. Riggs most recently was director of nutrition research at National Dairy Research Laboratories, Inc., and has been chairman of the Research Committee of both the National Cheese Institute and the American Margarine Assn.

◆ ◆ ◆

Newly appointed director of product development and quality control for Ocoma Foods Co., Omaha, Nebr., is IFT member **Walter E. Wood.** Mr. Wood most recently had served as quality control manager of a Council Bluffs, Iowa, frozen food company.

. . . Mr. Wood

◆ ◆ ◆

The Henszey Company of Watertown, Wis., announces appointment of **Raymond E. Paul** as manager of the Power Plant Specialties Division. Mr. Paul, a mechanical engineer with 10 years' experience in the petroleum industry, will be located at the main office, and will supervise expansion of the Henszey line of meter, blowdown equipment, and other power plant items. The company also manufactures multiple- and single-effect evaporators, spray dryers, vacuum pans, and vapor and steam preheaters.

. . . Mr. Paul

◆ ◆ ◆

IFT member **Geo. E. Brissey** became an associate director of research at Swift & Company on August 1. He joined Swift at the refinery laboratory of the Los Angeles plant in 1933, and also served at the company's laboratory at North Portland before becoming chemist in charge of Swift's zone laboratory at South San Francisco in 1939. During World War II, he rose to the rank of lieutenant colonel while serving in the Caribbean Defense Command at Panama. His new duties include responsibility for the firm's research divisions in canned meats, meats for babies, cured meats, table-ready meats, and Pard dog food.

. . . a Swift rise for Brissey

(Continued on page 56)

Now...a fresher-than-ever

IMITATION COCONUT FLAVOR!

With true flavor fidelity, Givaudan's Imitation Coconut successfully captures the fresh, subtle character of coconut.

This Givaudan development can be your key to coconut-flavored products that exactly suit the public taste. Our Imitation Coconut withstands high baking temperatures... brings out the full custard richness and creamy goodness of the real coconut flavor... has excellent shelf-life properties in your powdered products.

The mellow undertones of Givaudan's Imitation Coconut provide the flavor-rich appeal of fresh coconut for the greater success of your baked goods, candies, puddings, and powdered mixes. We invite your inquiries for both our liquid and powdered imitation coconut flavors.

Givaudan Flavors Inc.

330 West 42nd Street, New York 36, N. Y.

(Continued from page 54)

Andrew W. Hughes, with the company since 1943 in engineering, sales, and administration, has been appointed comptroller of Rheem Mfg. Co., 477 Madison Ave., New York 22, N. Y.

◆ ◆ ◆

. . . Peterson of CCC, ACS and IFT

Gordon T. Peterson, assistant to the packaging engineering manager of Continental Can Company's Metal Research and Development Center in Chicago, recently was voted chairman-elect of the Chicago Section of ACS. A charter member of IFT, Mr. Peterson is at present a councilor and member of the Executive Committee of the IFT Chicago Section. He is the author or co-author of numerous food technology papers, and co-holder of several patents relating to the processing of canned foods.

◆ ◆ ◆

The 83rd birthday of **Dr. Lee De Forest,** internationally known scientist and father of modern radio, was celebrated in Munich, Germany, on August 27 at a dinner party given by Beckman Instruments, Inc. Harold Zander, a salesmanager of Beckman's Munich plant, hosted the De Forests, who are on a six months' tour of Europe. Attending from California was **Dr. Wm. Shockley,** director of the firm's Shockley Semiconductor Laboratory and inventor of the junction transistor. While in Munich, Dr. Shockley also participated in an international symposium on semiconductors, basic material of the transistor.

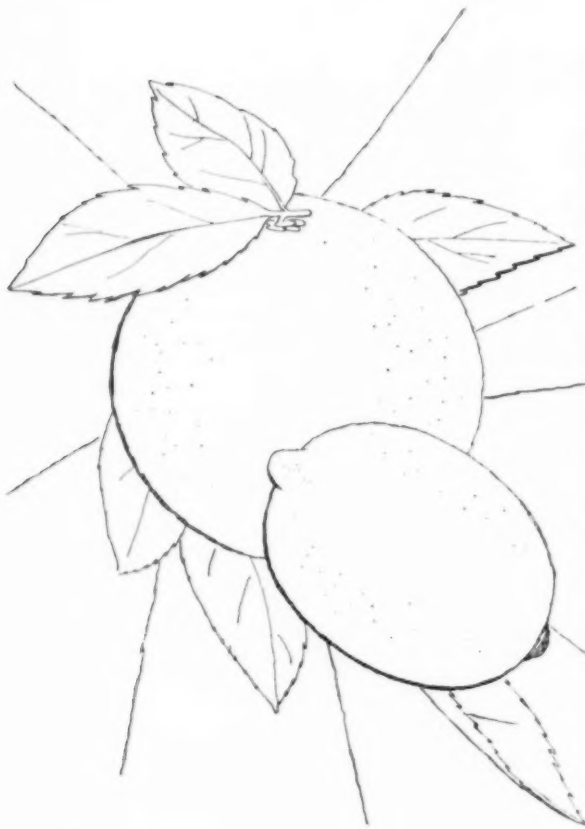
◆ ◆ ◆

Roger Corbett has been named sales promotion specialist for the Film Division of Olin Mathieson Chemical Corp., and will make his headquarters at the Division's offices at 655 Madison Ave. The Division manufactures and sells Olin Cellophane and Olin Polyethylene.

◆ ◆ ◆

Election of **Ernest Schleusener** as vice president, treasurer, and a director has been announced by Rodney Hunt Machine Co., Orange, Mass. Mr. Schleusener had been vice president of manufacturing, Mueller Brass Co., Port Huron, Mich., and a director of their Valley Metal Products Company subsidiary. At Rodney Hunt, he will have over-all responsibility for manufacturing and financial matters. The firm is a major producer of textile machinery, water control equipment, industrial rolls, and within recent years has become an important factor in the manufacture of chemical process equipment.

(Continued on page 58)



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For the luxuriant growth of all lactic acid bacteria yeasts and molds assured by the use of

EXCHANGE BRAND ORANGE SERUM AGAR #77
(Dehydrated) a Complete Culture Medium

FORMULA

Ingredients—when rehydrated on basis of 45 grams per liter of medium.

Orange juice serum solids	12.6g*
Agar (dry basis)	15g
Peptone	10g
Yeast hydrolysate	3g
Reducing sugars, total	8g
Sucrose, total	6g
Cysteine hydrochloride	0.001g

Buffered with 0.2 to 0.6g K_2HPO_4 to provide pH 5.5 ± 0.05 after sterilization.

**Equivalent to 100 ml 12° Brix orange juice serum.*

STANDARDIZED for uniformity and stability.

POTENTIAL APPLICATION—Orange Serum Agar as an all-purpose medium has a wide application to the bacteriologist and microbiologist in the milk, fruit, pickling, food, bottling and fermentation industries.

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PRODUCTS DEPARTMENT

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How to protect your foods against down-grading by using pure Diamond Crystal Flake Salt

Diamond Crystal *Flake* Salt has the highest uniform purity of any salt made. Ends danger of costly spoilage and "off" flavor from an impure granular salt or rock salt brine. Improves taste and keeping qualities of foods.

DO YOU KNOW what the calcium, magnesium, copper and iron in an impure salt can do to your products?

These impurities form unappetizing scums and discolorations on vegetables. Slow down curing of meat, make it tough and bitter-tasting. Give frozen fish poor texture and fishy taste. Cause oxidative rancidity in foods containing fats and oils.

Today's food market is keen. Competitive. The quality of your product is one of your best sales weapons. Why spoil it with an impure salt?

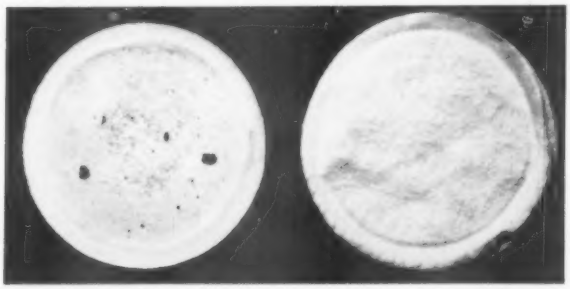
Why flake salt protects quality

Only Diamond Crystal is made by the exclusive Alberger system. This produces flake salt 99.95% pure. An amazing high purity that gives Diamond Crystal *true salt flavor* . . . without the bitter taste imparted by calcium and magnesium compounds, present in less pure salt. By using Diamond Crystal Flake you can *salt to the limit* for optimum flavor.

Diamond Crystal Flake averages less than 1.5 parts per million of copper or iron. Helps prevent oxidative rancidity and off-flavor development.

Are you using the right salt?

The grain size and rate of solubility of salt has an important effect on your product. That's why



Unretouched photograph of actual filter test shows difference in purity and cleanliness between a leading granular, cube-like salt (left); and Diamond Crystal Flake Salt (right).

Notice how impurities in the granular salt used discolored the corn on the left—while pure Diamond Crystal has protected the golden appeal of the corn at right. Which brand do *you* think the housewife would buy again?

Diamond Crystal Flake Salt is precision screened into a wide range of grain sizes to meet the most exacting *individual* requirements of your product.

Send for free analysis

If you are not sure that the salt you're using is suitable for your product, send a sample of it with the coupon below to Diamond Crystal. The salt will be given a careful laboratory test and the results forwarded to you free of charge.

Mail this coupon for free salt analysis

Technical Department FT
Diamond Crystal Salt Co., St. Clair, Michigan

I enclose a sample of the salt I now use. Please have it tested and send me the report free of charge. I would also like information on special Diamond Crystal Salts made for my industry.

Name_____

Company_____

Product_____

Address_____

City_____ **State**_____

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★ *Never a rise in temperature*

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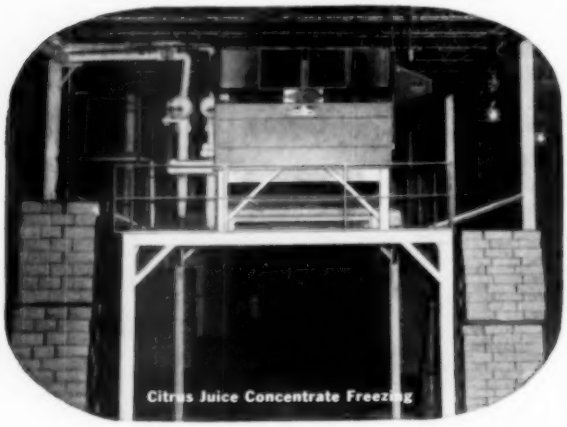
★ *Save Power . . . Reduce Costs*



Citrus Juice Concentrate Freezing

Write for Niagara Bulletin 105

NIAGARA BLOWER COMPANY

Dept. FT , 405 Lexington Ave. New York 17, N. Y.

District Engineers in Principal Cities of U. S. and Canada

(Continued from page 56)

Connor F. Lawrence, general manager of Sol Cafe Mfg. Corp., 180-04 Brinckerhoff Ave., Jamaica 12, N. Y., has received an "Award of Appreciation" from the Quartermaster Corps for his work as a member of an R&D Associates task group and a Quartermaster Industry Advisory Committee.

◆ ◆ ◆

Paul Orsay, sales manager of Alva Flavors Division of van Ameringen-Haebler, Inc., New York City, has announced appointment of **Wm. G. Paul** to the sales staff. Mr. Paul will serve food manufacturers and flavor users in the midwestern area from his headquarters in the company's Chicago office.

. . . Mr. Paul

◆ ◆ ◆

Dr. Walter L. Clark, a member of IFT, has joined the Food Technology Department of American Cyanamid Company's Research Division, Pearl River, N. Y. He was formerly an assistant professor in the Department of Biochemistry and School of Nutrition at Cornell University, where he was in charge of food science teaching. His particular specialization is research relating to the prevention of deterioration of foods by microorganisms and enzymes through the use of appropriate chemicals.

. . . another Dr. Clark of IFT

◆ ◆ ◆

Dr. Arthur L. Gordon, who was active in carbohydrate and amino acid research at the University of Minnesota, where he studied with the renowned Drs. Geddes and Jenness, has joined the research and development staff of Seaplant Chemical Corp., New Bedford, Mass., producers of natural plant hydrocolloids. In his new post, Dr. Gordon joins with other researchers in the company looking for new and better ways to stabilize, thicken, suspend, or otherwise improve food and other products through use of Irish Moss Extractives.

. . . Gordon researches at Seaplant

◆ ◆ ◆

Mr. O. D. Carlson, president of Modern Packages, Inc., has been appointed a vice president of Standard Packaging Corp., 551 Fifth Ave., New York, N. Y. He will retain his post at Modern Packages, recently purchased by Standard Packaging, and will be in charge of Standard's West Coast operations.

(Continued on page 60)

Something

new

Has Been Added To

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Originated by Specialists Working Within a Specialized Firm

YES—and it's Vanilla Laboratories special Cake Mix Flavor.

Cake Mix makers like it because it gives a distinctive flavor, is easy to use and control and, in addition, is budget-priced and individualized.

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Vanilla Laboratories special Cake Mix flavor is a *complete* flavor made exclusively by our specialists. By varying the basic formula (Pure Vanilla and other flavoring ingredients) we can give each cake mix maker his own unduplicated flavor.

Why not let us tell you about it, without obligation on your part, of course.

Basic Flavors
Individualized
For Each Cake Mix

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VANILLA LABORATORIES, Inc.

ROCHESTER, N. Y.

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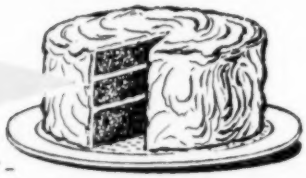
FINE FLAVOR

CAKES



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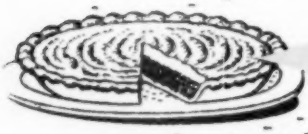
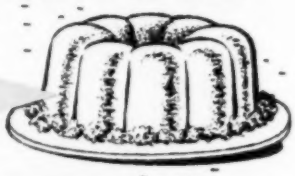


PIE FILLINGS

FOR THE FOOD

GELATINS



INDUSTRY.....

PUDDINGS

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(Continued from page 58)

Appointment of **R. Fullerton Stuart** as assistant manager of Carnation Company's frozen foods division, producer of Simple Simon brand frozen pies, cakes, and cookie rolls, was announced recently. Mr. Stuart will assist the division manager, Donald W. Hogue.

◆ ◆ ◆

Announcement has been made by Norbert H. Volle, manager of product development and research, Processed Foods Division, The Kroger Company, 1240 State Ave., Cincinnati 4, Ohio, of the appointment of **W. Carlos Mills** to the Product Development and Research staff. Mr. Mills formerly was associated with Kingam, Inc., Indianapolis, as research food technologist.

. . . Cincinnati's hills for W. Carlos Mills

◆ ◆ ◆

David T. Mitchell, until recently in charge of the firm's monosodium glutamate plant, has been named superintendent of the oil refinery section of A. E. Staley Mfg. Co., Decatur, Ill. He succeeds **Maurice M. Durkee,** retiring after 30 years with the company, who is credited with stabilizing the flavor of soybean oil. Staley also announces appointment of **Lyle C. Woods,** territory manager for the company's refined oil sales in the Philadelphia territory, as manager of the Chemical Department. The position is a newly created one established to align chemical sales with the development of new products by the company's Research Division.

. . . Mr. Woods

◆ ◆ ◆

An expanded meat processing research program at the University of Missouri will get under way following the recent additions of **Dr. O. J. Kahlenberg** and **Dr. Geo. G. Kelley** to the College of Agriculture faculty. The meat processing program is being carried on cooperatively by three College of Agriculture departments—animal husbandry, poultry husbandry, and home economics. Dr. Kahlenberg, named professor of poultry husbandry, will divide his time between the poultry and animal husbandry departments in the meat processing field. Dr. Kelley, named assistant professor of home economics and animal husbandry, will coordinate efforts between those two departments.

. . . Kahlenberg . . . hail Columbia!

In Memoriam

It is with deep sorrow that we report that Lewis H. Chrysler, a member since 1945 of IFT died on July 23, 1956, at the age of 56 years. At the time of his death he was a research chemist and project leader in the Research Department of the M & R Dietetic Laboratories, Inc. of Columbus, Ohio. He had been with this company for approximately 32 years.

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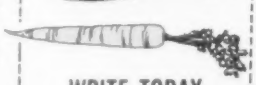

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both in their reactivity with proteins and their ability to work well "in combination" with other colloidal materials

*Over 20 distinct types of SeaKem Stabilizers are available . . . each one a highly refined derivative of Irish Moss and standardized for a particular gelling, thickening, suspending or other function.

Ask to be put on our mailing list to receive SeaKem EXTRACTS — the exciting house organ that "tells all" about SeaKem "Colloids Out of the Sea"

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Excellent opportunities—in a financially stable yet growing manufacturing organization—are offered to graduate chemists with extensive research and development experience in dairy, baking or cereal industries.

Located in metropolitan New York, our progressive company policy provides many employee benefits including life insurance and retirement plan.

Please forward detailed resumé of experience, education and salary requirements. All replies confidential. Our employees have been informed of this ad. REPLY BOX 496, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

FOOD TECHNOLOGIST-CHEMIST: Wanted for Production-Supervision and Lab., Products Development and Control. Knowledge of Meats and Meat Products required. Experience with spices, seasonings, additives helpful. Excellent opportunity for good man with growing firm. Salary commensurate with ability. Please send resumé to First Spice Mixing Co., Inc., 19 Vestry Street, New York 13, N. Y.

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Large aggressive Chicago cookie manufacturer offers opportunity for bakers with excellent baking talent.

If your success story is sufficiently convincing, we will pay you 25% more than you are earning today, and with this, a future for advancement in both income and responsibility.

If you are gifted with baking talent and bubbling over with ambition and good ideas you could easily become an important production executive.

Applications treated confidential. REPLY BOX 502, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

BAKER APPRENTICES

Large aggressive Chicago cookie and cracker manufacturer offers opportunity for men learning the baking business or who have had schooling in baking who wish to become top bakers.

If your success story is sufficiently interesting, we will pay you 25% more than you are earning today and offer you an excellent future for advancement in both income and responsibility.

If you have partially proved that you are gifted with baking talent and bubbling over with ambition and good ideas, the future would offer you an important production executive position.

Applications treated confidential. REPLY BOX 503, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

Mid-West Institutional food manufacturer needs experienced man for general line dry mixes (dessert, beverage, cake), soup bases, flavoring extracts, preserves, salad dressings and allied products. To assume responsibility for established formulations and procedures, quality control, new product development. REPLY BOX 504, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Man in Chicago area to take charge of Quality Control laboratory for soybean processor. Must have experience in handling people and background of suitable nature for soybean quality control work. Give experience and salary desired. REPLY BOX 505, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

FOOD TECHNOLOGISTS

Long established large multi-plant food company has two excellent openings in home office for an experienced Product Development man and a Staff Control Chemist with Statistical Quality Control background. Salary commensurate with qualifications. REPLY BOX 499, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Chemist and Food Technologist, B.S. Chemistry, 18 yrs. exper. in analysis, quality control and production in canning, flavors, cereal industry. Prefer production supervision or research. Phila. area. REPLY BOX 506, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Technologist, B.S. in Food Technology, 4 yrs. experience in product and process development. Desires position in production or technical service. REPLY BOX 500, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

Schwarz

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FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

October 9-12	American Dietetic Association, Milwaukee, Wisconsin
October 17-19	Nat'l Pickle Packers Association, Edgewater Beach Hotel, Chicago
October 23-26	Annual Meeting of the Association of Food Industry Sanitarians, Casa Munras Hotel, Monterey, California
November 12-15	American Bottlers of Carbonated Beverages, Public Auditorium, Cleveland
November 27-30	National Chemical Exposition, Public Auditorium, Cleveland
1957	
February 12-14	Technical School for Pickle Manufacturers, Kellogg Center, Michigan State University, East Lansing, Michigan
February 26-27	Fifth Annual National Dairy Conference, Kellogg Center, Michigan State University, East Lansing, Michigan
May 12-16, '57	**Institute of Food Technologists, Seventeenth Annual Meeting, Pittsburgh, Pa.**

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

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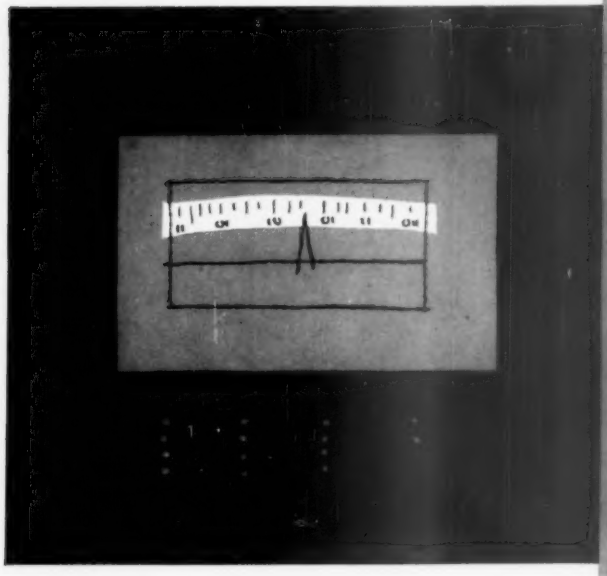

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